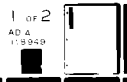
AD-A118 949 BUSINESS INNOVATIONS INC ALEXANDRIA VA F/G 5/9
THE UTILITY OF QUALITY CIRCLES IN UNITED STATES MANUFACTURING C--ETC(U)
JUL 82 S E HARPER, G L JORDAN N00014-82-C-0139
UNCLASSIFIED 4 NL



Unclassified
SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE	READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER 4	2. GOVT ACCESSION NO. AD-A118949 / 3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) The Utility of Quality Circles in U.S. Manufacturing Companies	5. TYPE OF REPORT & PERIOD COVERED Final
	6. PERFORMING ORG. REPORT NUMBER 1
7. AUTHOR(s) Stephen E. Harper Dr. Gary L. Jordan	8. CONTRACT OR GRANT NUMBER(s) N00014 82 C0139
9. PERFORMING ORGANIZATION NAME AND ADDRESS Business Innovations, Inc. 2413 King St., Alexandria, VA22301	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS NR 419-005
11. CONTROLLING OFFICE NAME AND ADDRESS Organizational Effectiveness Research Programs, Office of Naval Research, Arlington, VA 22217	12. REPORT DATE July 31, 1982 13. NUMBER OF PAGES 100
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office) Same	15. SECURITY CLASS. (of this report) Unclassified 15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for Public Release; distribution unlimited

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Productivity; quality circles; organizational effectiveness; job satisfaction.

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

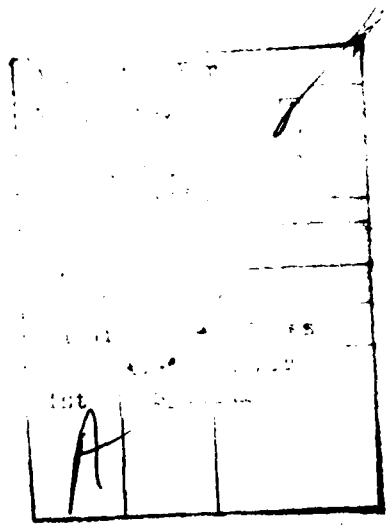
This research provides a systematic study of factors affecting the utility of quality circles as a technique for improving productivity. The results provide information useful for developing techniques to make optimal use of Navy personnel resources.

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

Unclassified
SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

Unclassified
SECURITY CLASSIFICATION OF THIS PAGE(When Data Entered)

Quality circles were established in organizations which differ in their work activities, their unionization, and their existing management practices. The effect of quality circles was examined and compared to matched work settings in which no quality circles were established. The work included the establishment and training of comparable quality control circles in each of 16 different work settings; the assessment of productivity and organizational effectiveness gains over matched groups in which no intervention was undertaken via a measure of productivity related and management-employee interaction patterns after three months of quality control circle operation.



Unclassified
SECURITY CLASSIFICATION OF THIS PAGE(When Data Entered)

MANAGEMENT SUMMARY

Introduction

This pilot study was performed by Business Innovations Inc., a research and consulting firm in Alexandria, Virginia, on 19 quality control circles (QC's) in four U.S. manufacturing companies, as the first phase of a comprehensive research project. The study was conducted over the period from January 1, 1982 to June 30, 1982. The primary study objective was to determine the feasibility of using quality circles to improve productivity in U.S. industry, and to determine whether this approach warrants further study in a second phase of research. The secondary objectives of the research were: (1) to measure the effects of the intervention of quality circles on productivity and related organizational factors (i.e., communications, style of management, job satisfaction, etc.), (2) to identify conditions which are related to the effectiveness of quality circles to improve productivity and descriptive mediating variables, and (3) to contribute to the science of management and organizational effectiveness.

Method

Four companies were selected for the study on the basis of diversity of industry, interest in quality circles, availability of existing practices for generating data on productivity, and ability to fulfill the study constraints of time and research design. The companies represented the

following industries: Company A, shipbuilding; Company B, pre-cast concrete; Company C, zippers; and Company D, electronics assembly. Work groups with diverse characteristics were represented in the population available within the four companies. These characteristics included differences in education of the employees, age, sex, job experience, size of the group, type of work, employment category and type of technology. A sample of matched pairs of work groups was chosen in each company on the basis of the above. Fourteen pairs of work groups were matched on the above characteristics. The employment categories of the pairs selected were: (1) Company A, white collar/non-union, (2) Companies B and C, blue collar/non-union, (3) Company D, blue collar/union. (At Company D the above sample selection procedure was not followed because the groups had been trained one year previously.)

Data were collected on productivity, management employee interaction patterns, characteristics of the workers and type of work as described above, and interviews/observations were recorded from the experimental and control groups. This data was collected before and after intervention by quality circle training in the experimental groups and at regular time intervals for 10-15 weeks after training. Similar data was collected on the experimental and control groups in Company D. The data from Company D spanned a one year time period from April 1981 to April 1982 and for the most part did not include productivity data due to changes in product mix, organization,

and high turnover which caused that data to be biased.

Productivity, the dependent variable in this pilot study, was measured by output per manhour divided by a standard output/manhour. Management-employee interaction patterns were measured by a Job Reaction Questionnaire(TM) (JRQ) form developed and validated by Honeywell Corporation. This questionnaire included eight scales specific to the following factors: work efficiency, cooperation, communication with management, personal influence, job knowledge, task significance, recognition/feedback, and job satisfaction. Data on these factors were used in the experimental design and data analysis as descriptive mediating variables and were treated as independent variables. The above described matching characteristics were also treated as mediating variables and these were obtained by survey and/or from company records. Analyses were performed using the Statistical Package for the Social Sciences (SPSS) to calculate T-statistics and multiple regression coefficients for each variable.

Results

This study was conducted as an exploratory pilot study. The sample size was too small and the time period too short for external validity to be established. The results are descriptive and do not show causal relationships.

1. Productivity Change

Measurable changes in productivity were found in the

quality circles and control groups at companies A and C. At the final data collection point, in Company C, the four measured quality circles increased in productivity 3.8%, while control groups decreased 9.6 %, a difference of 13.4%. At Company A the five quality circles measured increased productivity, 7.8%. However the three control groups measured increased productivity 36.5% at the final data collection point. During the entire study period average productivity at Company C decreased 8.2% in control groups and only 2.1% in quality circles. At Company A the average productivity over the entire study period increased 5.8% in quality circles and 20.2% in control groups. This unusual increase in productivity in the control groups at Company A was caused by historical bias due to procedural changes implemented by management to deal with a short term high production level situation. None of these changes in productivity were statistically significant.

The data on productivity at Company B were not included in the statistical analysis, because several groups experienced changes in product mix which introduced noncomparable changes in the units of productivity. The two departments where quality circles were present and measurable at Company B increased in productivity 8% and 39% respectively. The control groups decreased 27% and 17%.

The most likely explanations for the nonsignificance of differences in productivity are: (1) that the time period was too short for the quality circles to have a significant effect on productivity and (2) that the sample size was small.

(Significant differences can only be stated for consistent differences of large magnitude when small sample sizes are used.) None of the quality circles had implemented major changes in work methodology or design to improve productivity at the time of this report, although several had made minor improvements and some had received approval for major changes. Therefore, the non-significance was not unexpected. The differences which were found might become significant, if the identified trends continue for a longer time or if a larger sample is used in future research during a second phase of this research project.

2. Management-Employee Interaction Patterns

There were measurable and consistent improvements in management-employee interaction patterns as tested by the Job Reaction Questionnaire (see Appendix C). In Companies A, B, C and D the greatest improvements in the experimental quality circle groups as compared to control groups, were on the descriptive mediating variables measures of job satisfaction and communication with management. These improvements ranged from 3.5% to 31% more for quality circles, compared to control groups, depending on the company. In addition, quality circles improved more than control groups in cooperation, work efficiency, job knowledge, task significance and personal influence at Companies A and C. At Company B quality circles also improved significantly more than control groups in work efficiency.

At Company D, in a union environment, improvements were found over a one year time period on all of the above measures in the quality circles, compared to control groups, with the largest improvements coming in management communications (19%), personal influence (21%), and task significance (17%). These changes, which were not statistically significant, might become significant, if a longer time period or larger sample were used.

3. Mediating Variables/Regression Analysis

A significant correlation was found between one of the JRQ variables, perceived task significance, and productivity. The correlation was moderate at $r^2 = .39$ for quality circle intervention, company, and task significance taken together with productivity. The other variables including the other seven measures of management-employee interaction patterns on the JRQ were not significantly correlated with productivity. Analysis of variance also confirmed that none of the descriptive mediating variables correlated with productivity significantly. This result again may have been due to the small sample size and the short time period.

4. Interview Results

Interview data gathered at the three companies indicated that 14 of the 16 quality circles were considered successful by management and circle members. The two failures occurred due to one work group being split up and reassigned, and the other was due to the replacement of the work group's

supervisor. QC's were responsible for several improvements which were not detectable merely by analyzing the productivity data. The interview data was positive and indicated large improvements in morale, interdepartmental and vertical communications, personal development of the quality circle members, and generation of data useful to management. Several circles had proposed solutions to important problems, some of which were either not measurable in terms of productivity or which had not been implemented at the time of post-test data collection. For example, as of the date of the report, the circles at Company A have projected a return on investment of at least six orders of magnitude.

Enthusiasm for circles was very high for most circle members and was even greater, by testimony of the majority of the circle leaders and their immediate management. It will be interesting to see if this is an experimental awareness efect, a Hawthorne effect, or if it can be sustained over the long term. The Japanese experience is that quality circles need renewal and re-inspiration periodically[1]. The circle members and their management in this study also felt the quality circles mode of operation i.e., participative problem solving, is a very important practical tool for improvement of productivity in most, but not in all, cases.

1. Robert E. Cole, "Will QC Circles Work In the U.S.?" Quality Progress, July 1980, p.31.

Conclusions

It can be concluded that quality circles tend to improve productivity and management-employee interaction patterns for white collar and blue collar quality circles. It is not clear from the results in this study how great the improvements will be in any given situation.

The statistical data does not indicate major differences between the circles in the different categories tested in this study. However, the trend toward greater improvement in productivity in quality circles than in control groups is more consistent at Company C than A. In Company C most of the quality circles were blue collar while at Company A the quality circles were in white collar work situations. In addition to the unusual historical bias at Company A, companies A and C are very different in production process and organizational complexity. Areas encompassed by the study at Company A were observed to be under pressure due to scheduling fluctuations while total production at Company C was relatively stable over the experimental period.

Observational data indicated that the white collar quality circles had the least operating problems and non-unionized quality circles programs operated more smoothly than unionized quality circles programs. Nevertheless, the quality circles were seen as successful in unionized situations, and therefore it is not clear whether the presence of a union has a significant inhibiting influence. It is possible that the unwillingness of management to share decision making with employees causes strong union-related reactions to occur and

at the same time inhibits quality circles.

The eight variables measured by the job reaction questionnaire appear to be relevant mediating variables which affect and are affected by quality circles. Perceived task significance is definitely correlated with productivity. However, a high degree of participative management, cooperation or communication does not appear to be needed as a pre-requisite for successful quality circles. The intervention of quality circle programs appears to be related to changes in these variables.

The other descriptive mediating variables tested in the study do not appear to be important determinants of quality circle results. This may be an important finding if substantiated by a larger study. It suggests that quality circles are equally effective in work groups with very different demographic characteristics and work situations, including age, sex, education, type of technology, etc. This finding may be useful in dispelling any notions that quality circles require strong math education or that they require a participative management style to exist prior to implementation.

Further Research

The above conclusions indicate that the direction for further research should concentrate on management-employee interaction patterns as the most likely descriptive mediating variables in the success of quality circles. In addition,

variations in training, policy, and visible management support for the program seem to be important new variables to add as mediating variables, as a result of the observational data. A much larger sample size, 35 groups in each situation to be tested, and much longer time frame, 1-3 years, are needed to determine whether quality circles do cause an increase in productivity and what conditions maximize such improvements. Such further research can be carried out in a second phase of this pilot project.

ACKNOWLEDGEMENTS

I would like to thank Bob Hardison, Don Li[illegible]y, Russell Karr, and Hal Judy for making the study possible in their respective companies. I would also like to thank Dr. Audri Lanford, Dr. Marianne Maguire, and Dr. Gary Jordan for their invaluable assistance and encouragement. Special thanks to Dick Radwill, Curt Musser, and Bob Beckham, and Dean Ruble whose data collection assistance was critical. I would like to thank Wayne Reiker, Dennis Hecker, and Wingate Sykes for their expertise in quality circles training and implementation. Finally, I would like to thank Eileen Kozak for editing and typing this paper and all of the many other people who contributed to the study including the quality control circle members and the Office of Naval Research members who made the study possible and the Defense Small Business Advanced Technology Research Program (DESAT).

TABLE OF CONTENTS

INTRODUCTION

Definition of Problem Area and Objective of the Study

The need to improve productivity in the United States of America is of paramount importance for the economic well-being of the nation at this time. In the United States the productivity growth rate has been slowing for more than a decade and declined by 1.9% in 1980[1]. This trend is a serious threat to the economic well-being and political strength of the nation. Economically, this decline in productivity has contributed significantly to inflation. It has also eroded the competitive advantage of U.S. firms in both domestic and foreign markets.

The crises facing major U.S. industries have largely been due to the decline in U.S. productivity compared with the major gains in productivity by Japan, Germany, and other industrialized nations in the past two decades[2]. Japan is now leading the world in productivity growth[3], and quality circles (QC's) are one of several major factors which have helped Japan achieve this lead position[4]. As of September 1979, in most major Japanese manufacturing companies, approximately 85% of the workers were active in

1. The Decline of Productivity and the Resultant Loss of U.S. World Economic and Political Leadership (Dearborn, MI: Robot Institute of America, Mar. 1981), p.4.
2. Ibid.
3. Ibid.
4. Robert E. Cole, Work Mobility and Participation: A Comparative Study of American and Japanese Industry (Univ. of Ca. Press, 1979).

quality circles[5]. Quality circles grew out of work performed by American consultants in Japan and are just now being adopted by industry in the United States. Five-hundred U.S. companies have adopted quality circles according to a recent survey by the International Association of Quality Circles[6]. It is not yet known, however, whether quality circles will have the same effects on U.S. productivity as in Japan, because there are major and extensive cultural differences between Japan and the United States. One major difference is that the Japanese believe that quality is a central aspect of productivity, and quality circles there were part of a nation-wide effort to improve quality. The lack of emphasis on quality in the U.S. could reduce the likelihood of the success of quality circles as compared to Japan. The emphasis of quality circles in the U.S. is more on productivity than quality. These different focuses of QC's in the U.S. and Japan may have different results.

Many Japanese industrial practices foster a high degree of management-labor cooperation and create a favorable atmosphere for Q.C's. Joseph M. Juran, one of the originators of quality control training in Japan, states that the following three management practices contribute greatly to the success of QC's there[7].

5. Joji Arai, "Japanese Productivity: What's Behind it?" Modern Machine Shop, Vol. 52, No. 4, pp. 117-125, 1979.
6. "Short-term Fad or Long-term Fundamental? The Need For Research Into the Quality Circle Process," The Quality Circles Journal, Vol.IV, No.12, May 1981, p.26
7. J.M. Juran, "Japanese and Western Quality, A Contrast," Quality Progress, Vol.II, No. 12, pp.10-17, Dec. 1978.

1. Life-Long Employment for all Employees. QC's often involve their members in brainstorming ideas or innovations which streamline production. Often a good idea is proposed which can eliminate jobs. The Japanese worker has no fear of eliminating his own job, because he is guaranteed employment and the company will find another assignment for him. Generally, the American worker has no such guarantee and is highly unmotivated to improve productivity, if it means eliminating his or a friend's job. Life-long guaranteed employment builds strong company loyalty in the Japanese labor force.

2. Extensive Educational Programs for Employees. Japanese industry appears to be committed to developing the skills of their employees through extensive educational programs[8]. In fact, the main thrust of the quality circles movement in Japan was a major training effort involving nearly every segment of Japanese industry and taking nearly a decade to complete. Japanese QC's are trained in statistical methods of analyzing quality control which help them improve productivity. However, Dr. W. Edwards Deming, the main proponent of these statistical methods, has found that labor in the U.S. does not have adequate basic mathematical education to be able to quickly learn to use them, and U.S. companies have not generally been willing to provide educational programs for labor. The attitude that training is

8. Robert E. Cole, "Made in Japan- Quality Control Circles," Across the Board, Vol. 16, No. II, pp. 72,1978.

reserved for management, not employees, and the lack of training complementary to quality circles may lessen the effectiveness of quality circles in the U.S.

3. A High Level of Industrial Democracy. QC's involve labor in problem-solving and in making recommendations for work redesign to improve productivity. Thus QC's involve lower levels in the decision-making process usually reserved for higher levels in the U.S. In addition, the circles often require information for problem-solving which managers in the U.S. may be reluctant to share. Furthermore, managers in the U.S. seem to have a high resistance to accepting recommendations from people below them. Generally in the U.S. decisions are made at the top and passed down, but in Japan decisions are made at the lowest possible level and are passed up for approval. Rieker, Cole, and others believe that management resistance to sharing the decision making process with lower levels is the greatest single obstacle which QC's in the U.S. must overcome[9].

If Dr. Juran's theory is correct, then the success of QC's in improving productivity depends on a high level of initial cooperation between management and labor and also on the presence of the three industrial practices mentioned above. If these intermediate variables are not present, then the effectiveness of QC's may be reduced. It was this observation that caused Wayne Rieker to precede the introduction of quality circles with activities to improve

9. Ibid.

cooperation in the first successful implementation of QC's in the U.S. at Lockheed Missile and Space Company[10]. Even in Japan this approach was used in order to prepare management and labor to work together cooperatively and share decision-making[11]. Thus, the Japanese model for implementing QC's really is an attempt to change a large set of attitudes, practices, and social forces which determine the way management manages and interacts with labor. QC's, therefore, do not represent a technique so much as a way of managing and working which is often at odds with the managerial, labor, and social practices of U.S. industry. The change in attitudes, practices, and beliefs required by QC's is of such great magnitude in the U.S. that any number of social forces or mediating variables can greatly influence the effectiveness of QC's. Furthermore, corporations which introduce QC's and are not aware of the influences of mediating variables may find that QC's do not improve productivity.

This pilot study focuses on identifying the variables which in conjunction with QC's will produce improvements in productivity. It is important at this time that a larger study be done which identifies causal relationships between these variables. Without this knowledge many companies which experiment with QC's may leave out important variables and thus reduce QC's effectiveness.

10. Ibid.
11. Cole, Work, Mobility and Participation: A Comparative Study of American and Japanese Industry, p. 136.

The specific technical objectives of this study were to determine conditions under which QC's will improve productivity. The pilot study in Phase I tested QC's for productivity improvement under a variety of typical U.S. work situations. Fourteen descriptive mediating variables were tested for each of these work situations. Various technical objectives were set up during the pilot study design phase. The more significant of these are the following:

1. Degree of Cooperation/Management-Employee Interaction Patterns. This descriptive variable has two aspects. The first is whether QC's are more effective in organizations in which a high degree of cooperation, communication, and participative interaction patterns are already present. The second aspect of this variable is whether QC's will cause an improvement in these interactions in the company unit or division. QC proponents believe that both of the above mentioned hypotheses regarding cooperation, communication and participative style of management are true. This study tested the level of work efficiency, cooperation, communication, personal influence of employees, job knowledge, perceived task significance, recognition/feedback, and job satisfaction with a pre-test and post-test questionnaire.

2. White Collar Versus Blue Collar. Wayne Rieker and other QC circle trainers have found that the approach is usable by white collar work groups[12]. Many consultants

12. Wayne Rieker, personal interview, February 1982.

believe that greater improvements in productivity are available when QC's are used by management and other white collar work groups, than by blue collar groups. If QC's do improve productivity for white collar work groups, the implications for the United States will be very important, because a large share of the work force performs very similar types of tasks throughout most industries and government. Furthermore, white collar work groups typically have a greater opportunity to improve productivity than blue collar, because their actions have wider ramifications throughout the organization. Dr. W. Edwards Deming, founder of the quality control movement in Japan, has stated repeatedly that 85% of the problem of lack of productivity in the U.S. is caused by management. The potential for improving productivity by applying QC's to white collar work groups is therefore very large.

3. Union Versus Non-Union. The question of whether QC's can succeed in union as well as non-union industries is particularly important in the United States. QC author Robert E. Cole states that it is more difficult for QC's to be successful in unionized industries than non-union industries because of the adversary relationship which often exists between labor and management. He states that the QC effort currently underway at General Motors Corporation is extremely significant because it is the most difficult test to date for QC's. If it succeeds there it should succeed in other less

13. Cole, "Made in Japan- Quality Circles", Across the Board, pp.72-78.

hostile environments[13]. Phase II of the present study will attempt to compare improvements in productivity made by QC's operating in union and non-union situations in more completeness than has been possible in Phase I.

4. Matching Criteria. Each of the descriptive variables used for matching test pairs were also analyzed to determine to what extent these account for any changes in productivity. A comprehensive discussion of each of these descriptive variables is provided in the methodology section.

REVIEW OF RELATED RESEARCH AND PRODUCTIVITY IMPROVEMENT TECHNIQUES

It is surprising that in spite of the proliferation of QC's in Japan and more recently in the United States no definitive or controlled studies on QC's have been published. Nevertheless, there is an abundance of data which have been collected by Japanese and U.S. companies on the effectiveness of their QC's. Most of these data are in the form of cost savings to the company resulting from problems solved by QC's. The reported cost savings are impressive. At Lockheed Missiles and Space Corporation, the savings from recommendations made by QC's were six times greater than the costs of implementing the recommendations and running the QC's program. The Norfolk Naval Shipyard implemented a pilot study on nine QC's in 1979. In one year the program reported a $7 million savings in costs avoided due to QC's[14].

14. Steve Bryant and Joe Kearns, "The Quality Circle Program of the Norfolk Naval Shipyard", Exemplary Practices in Federal Productivity, U.S. Office of Personnel Mgt., Apr. 1981.

Nissan Motor Corporation in Japan reported in 1978 that its 4,161 QC's dealt with 30,000 projects and saved $2,400,000.00[15]. However these cost savings are an incomplete measure of productivity. Their reliability is suspect, since the same cost savings could have occurred in other ways. Standard measures of productivity compared to control groups, such as those used in this study, are needed.

There is a wide variety of productivity improvement and quality control programs available in the market today. These can be put into two general categories: (1) Those which concentrate on tapping human mental factors such as creativity, communication, cooperation, and motivation and (2) those which deal with non-human or physical factors such as statistical measurement and analysis, modernization of plant and equipment and design modifications. According to the literature, both groups of techniques have made significant contributions to the growth of productivity. The greatest growth in productivity generally occurs when techniques from both categories are used simultaneously. QC's are one of the few comprehensive, productivity improvement techniques which employ elements of both categories.

Statistical analysis techniques of improving quality control have been championed successfully in Japan by Dr. W. Edward Deming[16], often referred to as "the father of quality

15. "Quality Control Circles Pay Off Big," Industry Week, Oct. 29, 1979, pp. 17-19.
16. W. Pabst, "Motivating People In Japan," Quality Progress, Vol. 5, No. 10, pp.14-18,Oct.1972.

circles Dr. Deming taught personnel in QC's in Japan to use statistical analysis to adjust production machinery for optimizing quality and productivity. Quality was quantitatively calculated to be included as a partial measure of productivity. Quality improvement became a national movement in Japan and Quality Circles became a part of that movement. The QC's learned Deming's techniques, but also added several aspects of group dynamics which increased the effectiveness of the QC's.

Dr. Deming found that in the United States labor does not have sufficient mathematical education to learn the statistical methods of analysis. Instead, he has concentrated on teaching the techniques to management in the U.S. Nevertheless, it has long been known in the U.S. that simply putting so much attention on productivity as is required to measure it usually produces an improvement in productivity i.e., the Hawthorne effect. Even though QC's in the U.S. may or may not use as sophisticated statistical analysis as QC's in Japan, they do use many quantitative analytic techniques to measure quality and productivity. It could be that the act of measurement is more important than the technique used. This would indicate that many of the results are due to attitude and attention of the employees rather than technique of data analysis. Employees measuring their own quality and productivity with the self-motivated goal of improving it is a rare phenomenon. It is a remarkable change from the traditional adversary relationships created by management collecting such data and using it to reprimand lax employees. The adoption of this

kind of activity by employees in quality circles appears to be a more dramatic change than the adoption of specific techniques used to evaluate quality or productivity data. This change in attitude has been accomplished in quality circles, it is hypothesized, for several reasons. (1) Quality circles assume that the causes of poor quality/productivity are not known by either management or employees, and therefore placing blame is avoided. (2) Quality circles assume that employees are motivated to and are capable of identifying and solving problems and redesigning work to achieve improvements in productivity. This assumption becomes true partly because it is expected. (3) Quality Circles assume that employees share company objectives. (In quality control circles training problems of quality and productivity typically are related graphically to job security.)

The proponents of QC's in the United States emphasize that QC's stimulate workers to think about their jobs and to apply creative intelligence to improving productivity and quality. When this is done by a group working cooperatively as a team, the results can be a large number of innovations, improved feelings of self-worth and self-respect, improvements in morale and motivation, and improved communications and cooperation between workers and among management and labor.

The contribution of ideas and innovations from quality circles is chought to be more valuable than harder work, although both may result from quality circles programs. Stated another way, working smarter cooperatively is more

productive than working harder. Quality circles employ techniques for stimulating innovative thinking. These include brain-storming and cause-effect analysis. The use of such creativity stimulating techniques by groups has been explored extensively with respect to new product development by A.D. Little, Innotech, Synergistics, Business Innovations, Inc. and others. Since productivity improvements often occur from innovations in technology, it is also likely that innovations in work flow, procedure or design, such as quality circles produce will also improve productivity.

Self-actualization is another concept which is used to describe the benefits of quality circles in terms of development of full human potential. A large body of literature exists which describes the positive relationship between self-actualization and productivity. This relationship is relevant to the study because QC's are felt to be a vehicle which increase self-actualizing behavior of participants. QC circle members are asked to draw on their potential as it affects productivity. This can cause participants to develop abilities they did not previously know they possessed.

Whether it is due to greater creativity, skill, or effort, most productivity experts support the theory that developing the full potential of the abilities of the employees is an important factor in improving productivity. QC's in Japan and the U.S. emphasize training and development of the groups members. QC's typically spend considerable meeting time in training in the early stages, and

later as needed. This training may improve work skills as well as problem solving skills, creative and analytic skills and communication and human relations skills.

The Japanese approach to productivity blends the humanistic and the technological approaches. Japanese investment in modern equipment is outpacing U.S. industry, notably in the steel industry and in the use of industrial robots[17]. Deming's methods of statistical analysis are used widely in Japan[18]. At the same time QC's help to develop the human resources of the firm and stimulate the employees' creative thinking about productivity improvement. Q C programs are usually coherent company-wide efforts to improve productivity and this may be another reason for their success.

17. Otto Friedrick, "The Robot Revolution," Time, 8 Dec., 1980, p. 75.
18. W. Pabst, pp. 14-18.

METHODOLOGY

Conceptual Framework

This study was planned to test changes in the dependent variable, productivity, after the intervention of quality circles. A longitudinal, controlled, field research design was used. Matched pairs of work groups were divided among test groups which were trained and activated as quality circles and paired control groups which continued normal operations.

The independent variable was the presence or absence of quality circle training and activity in each of the groups. The situations studied were actual functioning work groups in industry. A large number of descriptive mediating variables were also measured on pre-test and post-test bases for each of the groups. The first subset of descriptive mediating variables related to management-employee interaction patterns. The second subset related to the work conditions within which the paired groups functioned and the characteristics of the workers within the groups.

The experimental design was followed by selecting paired groups in different work situations. The second subset of descriptive variables was held constant within each pair of groups and by design varied between pairs. This variation was made in order to study a wide range of different work situations so that the results would have greater external validity. The effects of the descriptive mediating variables of both of the above subsets on the relationship between the dependent and the independent variables were then studied by

various techniques. The number of variables tested under this design was limited by both manageability and funding.

According to this framework it was possible to test multiple hypotheses about the effects of a number of independent variables on the effectiveness of quality circles in improving productivity:

I. The principal hypothesis for the dependent variable was:

Quality circles improve productivity in many different types of manufacturing situations in the U.S.

II. Hypotheses relating to descriptive mediating variables were the following:

1. For the first subset:

A. Q.C.'s improve management-employee interaction patterns as represented by:

1.1 Work efficiency
1.2 Cooperation
1.3 Communication
1.4 Influence of employees
1.5 Job knowledge
1.6 Perceived task significance
1.7 Recognition/feedback
1.8 Job satisfaction

Stated in this way the first subset variables were first analyzed as dependent variables with respect to the independent intervention variable. They were also analyzed as descriptive mediating variable with respect to productivity in hypothesis B.

B. Quality circles improve productivity more when management-employee interaction patterns have a high degree of participative decision making as indicated by the above eight measures.

2. For the second subset of mediating variables the hypotheses were:

2.1 Quality Circles improve productivity more in white collar than blue collar groups.

2.2 Quality Circles improve productivity more in non-union than union work groups.

2.3 Quality Circles improve productivity differently depending on which of the following types of production processes are involved:

Custom
Large Batch
Small Batch
Manufacturing Assembly Line
Continuous Process

It is not known whether quality circles improve productivity in one type of production process more than another. However, many experts do believe that the amount of labor content in the process is an important variable which is partially measured here. Custom processes generally have the highest labor and continuous processes have the least.

2.4 Size of the work group mediates the influence of quality circles on productivity. It is thought that small groups are more effective than large ones for participative problem solving.

2.5 Age mediates the influence of quality circles on productivity. The influence of age is not known. However, younger employees may be more willing or able than older employees to accept the change to participative management style that quality circles bring.

2.6 Quality circles improve productivity differently depending on whether the employees are male, female, or mixed groups.

2.7 Quality circles improve productivity more when members have more education.

2.8 Work experience of members mediates the influence of quality circles on productivity.

2.9 Quality circles improve productivity more when members have held more different jobs at the company. Job rotation may broaden the awareness of employees and help in the problem solving process of quality circles. This practice is used widely in Japan.[18]

Study Design

The study was a longitudinal design using experimental field pairs which were pre-tested and post-tested. The symbolic representation of this design is:

Selection	Group	Pre-test	Q.C.'s	Post-test 4 Weeks	8 Weeks	12 Weeks
R	Test	0	X	0 1	0 2	0 3
R	Control	0		0 1	0 2	0 3

O - Designates data collection
X - Designates implementation of quality circles
R - Designates random assignment.

The groups in each pair were matched on as many of the second subset of descriptive mediating variables as posible. After pretest data collection of all variables one group in each pair was randomly assigned to be trained and operate as a quality circle. No changes were made in the control groups other than those external to this study design.

18. Robert E. Cole, Work Mobility and Participation: A Comparative Study of American and Japanese Industry, (Univ. of Calif. Press), p.139

Sample Selection

Companies

Approximately 75 manufacturing facilities were originally contacted as candidate locations for the study once funding was assured. About 20-25 facilities indicated initial interest in participating. Negotiations and a process of elimination took approximately 1-2 months. The requirements of the participating companies were in the following order of importance.

1. They could start a pilot quality circles project within 1-2 months.
2. The companies would be able and willing to share productivity data on identifiable work groups.
3. The nature of the work arrangements would permit matched control groups to be studied.
4. A variety of types of work groups from white collar and blue collar and union and non-union situations would be available for study.
5. The companies represented different industries to enable greater breadth of generality and external validity of conclusion.

None of the companies were able to meet all of the requirements. None were able or willing to allow quality circles to be introduced in unionized work groups during the time period of this study. Three companies, A, B, and C, which met the other criteria

for most of their employees, were selected to start the study. Additional contacting continued to broaden the data collection effort which resulted in the addition of some historical data from a fourth company, Company D, which involved unionized work groups. The company had implemented quality circles about one year previously (April, 1981). However, no matched control groups could be identified and the available productivity data was determined to be heavily influenced by historical events. Consequently the data on Company D, including the management-employee interaction patterns, were analyzed separately from the first three companies. None of the original three companies had any previous experience with quality control circles. All of the companies are U.S. owned and operated. Industries represented were:

Company A- Commercial Shipbuilding
Company B- Pre-cast Concrete Mfg.
Company C- Zippers Mfg.
Company D- Electronics Assembly

Company A is a large well-known shipyard with several thousand employees concentrated in the same location. The hourly employees are represented by an aggressive national union. The company has been in a steady state of production and has had moderate growth for several years. Production activity is cyclical depending on the state of completion of each ship.

Company B is a pre-cast concrete manufacturing subsidiary of a large building materials company in the southwest. The production scheduling is cyclical depending on stage of completion of the building, architectural drawings and among other things, weather. The 300-man labor force is non-unionized and is about 60% Spanish speaking.

Company C is an established zipper manufacturing subsidiary of a large textiles company. The company has experienced declining zipper sales for several years due partly to foreign competition. This has caused a long term reduction in the labor force which is predominantly female, with longer employment history than at either company A or B. In the past year, however, sales and employment have stabilized. Production is less cyclical and more continuous than at Company A or B.

Company D is a mid-western electronics assembly facility of a large telecommunications company. It has about 1,000 employees represented by the Communications Workers of America. The company has had a high turnover of employees and several changes in their product mix in the past year. These influenced the productivity measures and the quality circles program significantly.

Criteria for Work Groups

The sample groups were defined by the condition of the

employees reporting to the same supervisor and by the existence of a common identifiable work group output. Forty-one groups were selected as candidates for matching from the first three companies. This sample size was chosen because it was sufficiently large for a pilot study, yet small enough to be accomplished within the time/cost constraints of Phase I. The matching criteria used were: (1) similar type of work, equipment and productivity measures, (2) the same plant location for each group in the pair, and (3) the second subset of descriptive mediating variables: group size, average age, sex, years of education, job experience and number of jobs performed for the company.

Data on the mediating variables were collected for each of the sample groups and are described thoroughly in the data collection section. The characteristics of the groups were compared and 13 pairs were identified. Two groups for which no matched pairs were found were also trained as quality circles. The average of the members of each work group on each variable was compared. Since an exact match was difficult to obtain, an iterative process was used until the groups were arranged in pairs such that no variable differed between the groups in each pair by more than 30%. In most cases the variation was less than 10%. Fourteen pairs were originally matched in this way. Two groups for which no match was found in Company A were also included.

Matching was not attempted on the management-employee interaction patterns or previous productivity history, because the results of this data scoring were not available quickly enough, and this variable was controllable through covariant analysis. Other variables which affect success of quality circles, including method of introduction, quality and type of training, and the ability of the in-house facilitator/program coordinator were kept relatively constant. The same training and procedure of introduction was used at Companies A, B and C. Company D varied by the use of different consultants and by the addition of circles during the one year time period. The facilitators at all the companies were very capable and well chosen for their tasks.

Sample Parameters

The pairs of work groups represented different technologies including custom, large batch, small batch, and continuous assembly line manufacturing situations. A broad range of pairs was included with wide variations in age, education, sex, work experience, and group size. These descriptions are tabulated in Appendix D. The sizes of the groups depended on the work situation and ranged from 4 to 15 with an average of 7. Only two pairs were not matched on this variable (Pair 1 at Company B and Pair 4 at Company C).

The work groups in the study also represented the following work conditions:

	BEGINNING			ENDING	
	Test	Control		Test	Control
Company A	7	5	White Collar	5	3
Company B	3	3	Blue Collar	2	2
Company B	1	1	White Collar	0	0
Company C	4	4	Blue Collar	4	4
Company C	1	1	White Collar	0	0

Four white collar pairs were eventually dropped from the study when it was determined that efforts to measure their productivity were unreliable or not comparable to their control groups. One blue collar pair at Company B was dropped because the two work groups in the pair were dissolved and reassigned so that they no longer constituted work groups. The productivity data of the other two pairs at Company B were also dropped from statistical analysis, because major changes in product mix occured during the study which made the measures of productivity not comparable over time. These data nevertheless appear in Appendix B. The majority of the data analysis was therefore performed on four blue collar pairs at Company C and three white collar pairs at Company A.

Data Collection

Dependent Variables

The data on the dependent variable were collected as follows. Actual productivity data on past performance were collected by the department heads/production managers at Companies A and B; these were from records of weekly output/manhour reports for the groups involved. At Company C past productivity data was collected from company incentive system records in the industrial engineering department. At Companies A and C the productivity data were supplied as output/manhour divided by standard output/manhour. At Company B no standards existed.

Several measures of productivity were collected, but only units of ouput/manhour was ultimately utilized. The units of output/manhour were consistent between each group and its pair, but necessarily varied between pairs due to the different work situations encompassed within the selected samples. In order to obtain a comparable measure betweeen pairs the percent change in productivity from the pre-test baseline was calculated for each of three post-test time periods, T_1, T_2, T_3. T_1 included all data from 1-4 weeks after beginning quality circles, T_2 from 4-8 weeks, and T_3 from 8 to 12 weeks. The baseline pre-test data was an average of 1 to 6 months past performance. The averaging period for the baseline data at Company A was two months, Company B was 1 month and Company C averaged five months. The data from one white collar pair at Company A was not included in T_2 and T_3

because it was determined that procedural changes occurred which uncontrollably affected the measures of productivity.

The productivity data which were retained for analysis are believed to be consistent comparable data with a relatively high degree of reliability. The data at Company C were compiled from incentive system records which closely track output of each individual in the group. Also, the units of output at Company C were highly uniform while they varied in uniformity somewhat at Companies A and B. The productivity measures covered 70-100% of the groups' work time. In Phase II more measures of productivity will be added. The productivity measures used were:

For Blue Collar Groups:

A. Output/manhour. The actual output/manhour was divided by standard output/manhour for all but one pair where no standards had been set. The use or non-use of a standard was constant within pairs.

B. Scrap and rework rates were collected, but were not ultimately used because of lack of consistency in method of data collection.

For White Collar Groups:

A. Direct output/manhour as a percent of standard as above. For example, for data processing the number of entries/manhour was used. The units of output were less uniform for the white collar groups than the blue collar groups. For example some units require more work than others, but all are counted the same. Standards did not exist for three of the white collar circles at Company A.

B. Achievement of objectives expressed as output/time or output/cost. For example, the measure of output of an accounts receivable department is the average number of days accounts receivable are outstanding. This measure is often the basis for calculating cost savings due to a specific quality circle suggestion. It was included in interview data, but was not quantitatively analyzed in this study.

For Groups With No Existing Measure:

In four white collar pairs, #1 and #2 at Company A, #4 at Company B, and #5 at Company C, there were no existing measures of productivity. Measures were developed and a pre-test of productivity was taken for each group. However, the measures in each case were partial and counted non-uniform output in some cases. The method of collection was also not tightly controllable. For this reason none of these four circles were ultimately included in the data analysis with respect to productivity. This reduced the number of pairs in the study from thirteen to nine. The number was further reduced to seven pairs when it was determined that the remaining two pairs at Company B changed product mix during the study which therefore made the pre-test and post-test measures of productivity not comparable. As with Company D, the data was retained for descriptive purposes and analyzed separately.

Matching and Data Collection on Descriptive Mediating Variables

A checklist of activities was created to help guide the data collection and the matching on descriptive variables (see Appendix A). The first step was an analysis of operations performed at each of the three companies to determine the most likely pairs of groups which could be matched on the descriptive variables. It was also attempted to include pairs which differed on the most important descriptive variables to provide an adequate range of data. A list of probable pairs of groups was compiled. A three page questionnaire was given to each member of the work groups on the list which tested descriptive mediating variables associated with demographic characteristics and work history of the groups (see Appendix A). The Honeywell Job Reaction Questionnaire was also stapled to the questionnaire with a cover instruction sheet (see Appendix C). The questionnaires were coded to identify the work group, but not the individual, and a composite group average was compiled on each question. Simultaneously interviews were held with the department head and/or industrial engineer to determine the type and age of equipment, nature of the work process and historical events affecting past productivity. It was also determined in these interviews that the work groups in the study were insulated from each other.

The descriptive mediating variables were used to describe the conditions under which the productivity changes occurred. To the extent possible these intervening variables

were held constant between each group and its pair so as to isolate the independent variable, quality circles. However, these variables were expected to vary within the total group of matched pairs. Thus, a range of characteristics of the work groups and work environments were tested, but each group had a controlled pair matched for these characteristics. The data on the descriptive mediating variables were used to define the sample parameters and werecollected as described above. The variables were as follows:

1. Characteristics of the Employees Group Members (Average):

   A. Age
   B. Sex (percent male)
   C. Education (No. of years)
   D. Relevant work experience (No. of years)
   E. Years employed by company
   F. Number of jobs performed for company
   G. Training by company (No. of days).

2. Characteristics of the Work Group

   A. Number of persons in the group.

   B. The total number of people supervised by the groups' managers.

   C. The number of different job titles in the group.

   D. The number of hours the group normally spends in meetings.

   E. Previous productivity history measured according to output/manhour. The previously existing level of productivity of each group in the pair at the time of Q.C. training was similar in most cases. Nevertheless differences were controlled in the data analysis by covariant tests.

F. Union or non-union. Union QC's and non-union QC's were expected to perform quite differently. Therefore this variable was used for matching the groups in each pair.

3. Characteristics of the Work

A. Type of work being performed. For measures of productivity to be comparable, the type of work being performed must be comparable. This was an important matching criterion but could not be used as a descriptive variable as there is no meaningful interval scale. Therefore only the nominal white collar and blue collar distinction was made.

B. Technology, type, age, and sophistication of plant and equipment. The type of equipment being used has a major influence on productivity. It was determined that two groups in each pair were using similar types of equipment to perform their work.

A seven point scale rating the degree to which each of five types of technology were used by the work groups was used (see Appendix D). The five types of technology were:

Custom
Small batch
Large batch
Manufacturing assembly line
Continuous process.

4. Management employee interaction patterns.

To measure the management style of the organization, the 44 question Job Reaction Survey developed by Honeywell

Corporation was used (see Appendix C)[19]. This survey was administered before and after the experiment to every member of the test and control units. The questions ask to what extent the respondents share organizational objectives, are involved in problem solving, feel their judgement is respected, perceived their tasks as significant, give and receive feedback, etc. These organization norms are indicative of the management style and level of cooperation present in the company. The survey was scored according to a five point interval scale for each question. The higher the scores; the higher the degree of participative decision making, cooperation, and communication, etc. The eight scales were:

1. Work efficiency
How efficient the work group is as seen by the group members.

2. Cooperation
How good cooperation is between individuals in the work group and with other work groups and departments.

3. Management Communication/Response
Tests how good communication is between the work group and the management of that group.

4. Personal Influence
A measure of the degree of participative style of management. These questions test the amount of personal influence the work group members have in solving work related problems in their work areas.

5. Job Knowledge
Tests whether the job is using the employees' abilities and whether they are increasing their job knowledge over time.

19. Gail Drauden, Corporate Human Resources Research Department, Minneapolis, MN., 1980.

6. Task Significance
Tests to what degree employees feel their jobs create output which is useful to other people.

7. Recognition/Feedback
Tests whether employees feel they are recognized for their work and are given direction on how they can improve.

8. Job Satisfaction
Tests overall satisfaction with the job.

The data on the descriptive mediating variables were taken from the questionnaires to the group members and department heads the questionnaires were used for matching work groups and were described earlier. There was a large amount of missing data on the three questions dealing with wages and company training. Many entire work groups declined to disclose their wage level and this question was dropped. Confusion over the definition of training was evidenced by many respondents. Some definitions included university courses partially paid for by the company. Others included OJT training. It was ultimately determined that no structured company training other than on the job training had been received by a significant number of people in any of the work groups. There was little missing data on any of the other variables.

A post-test of the Honeywell Job Reaction Questionnaire was given to the test and control groups approximately 12-14 weeks after the quality circles were trained at Companies A, B and C. At Company D the post-tests were taken three months and one year after quality circles were begun.

Selection of Work Groups for Experimental And Control Assignment

Once the pairs had been matched a random selection was made to determine which group in the pair was to become the quality circle. However, several assignments were not made randomly. Pair 1 at Company C consisted of the first and second shift crews in the same work area. Management did not feel that adequate training or support could be given to a quality circle on the second shift during the start-up phase. The first shift was therefore assigned as a test group. Two other assignments, Pair 2 at Company A (A2) and Pair 3 at Company C (C3) were made on the basis of the need to preserve insulation of the test groups. This was due to known social and work interaction patterns of the groups. In these cases the control groups were insulated from quality circles, but not from other work groups in the company. Therefore they could not become test groups. Random assignment was made for the other groups. Once the selections had been made, the supervisors of the test groups were asked if they would volunteer to become quality circle leaders. When two leaders did not volunteer the other group leaders in the pairs were asked to volunteer. Both groups, six at Company A (A6) and four at Company B (B4), agreed and became the test groups in the pair. Since Pairs 2A and 4B were eventually dropped, three of the seven pairs used in the productivity analysis were not randomly assigned.

Most quality circles experts agree that it is important that quality circles should be a voluntary activity. This

issue presented a problem with regard to random assignment as seen above. In this respect the voluntary nature of quality circles creates a non-random, self-selection influence in all quality circles. It was feared that frustration and covert QC-like activity might occur if managers were asked to volunteer to lead a quality circle, but were then not allowed to if they were assigned as control groups. Thus, no pre-testing of willingness to volunteer was done prior to random selection. Willingness to volunteer for the program could be pre-tested via questionnaires for all groups, but this could bias the results of other data.

QC Training Intervention

The test groups were trained in quality circles following the Japanese format which has become a standard in the U.S. The first implementation step consisted of familiarizing the concept of quality circles to management at each company and establishing a steering committee with top and middle management. The steering committee then established guidelines for the program and an implementation schedule. The committee also chose an in-house coordinator/facilitator and the supervisors of the test groups were given an opportunity to volunteer for the program. This was accomplished in about two on-site consulting days at each company. Approximately one to two weeks later the facilitator and volunteering test group supervisors received four days of training in quality circle concepts. This included training

in group dynamics, problem solving, data collection and analysis and making presentations to management. The trainees were taught how to train the work groups which reported to them, the quality circle members, in the same techniques. Information on total operation of the quality circle in a step by step format was fully communicated. At this time a seminar overview of quality circles techniques was given to middle management of the departments where quality circles were implemented.

This training was performed by two experienced consultant/trainers, Dennis Hecker, President of The Productivity Group, Austin, Texas, and Wingate Sikes of Productivity Development Systems, Inc., Largo, Florida. Training materials were provided by Productivity Development Systems. They included a manual for each group leader, slides and audio tapes on the quality circle techniques, and video tapes of a quality circles using each technique. The manuals, slides and audio tapes were subsequently used by the group leaders to train their work group members.

These training materials were chosen after a review was made of the various materials available on the market. These quality circles materials had the advantages of emphasizing the wholistic concepts of problem solving and group leadership. The video tapes also supplied a valuable role modeling tool for the trainees to learn quality circle behaviour. This was lacking in the other materials reviewed.

All of the group leaders began operation of a quality circle in their work group within one to two weeks after

receiving training. Participation by work group members was voluntary and exceeded 90% in most cases. Pair 3 at Company A split into two circles of seven and eight members respectively, when the number of volunteers reached 15. The circles met once per week for one hour for the duration of the study, except for two groups which were dropped from the study. At Company D there were seven original quality circles and thirteen more were added after five months. However, the membership in the circles changed as employees were reassigned to different departments.

Limitations

The results of this exploratory pilot study are suggestive of the relationships between productivity, quality circles and several descriptive mediating variables. These results are not definitive or causal, but descriptive, and identify the most logical, appropriate direction for further research.

Internal Validity

The data on the pairs in the study are relatively consistent and complete. When measures were not complete across most groups in the study, those measures were not included in the quantitative, statistical analysis. Thus, the remaining data had a high degree of consistency. For this reason and because the data were systematically collected, a high degree of confidence in internal validity may be expected in most cases. Exceptions to this are the productivity at Companies A and B and the data from Company D. In these exceptions the data showed wide fluctuations and did not control for influences of variable demand, scheduling and procedural changes, both of which managers said affected productivity more than any influence the employees could conceivably have had. The data from Company D on both the JRQ were not tightly controlled by the researchers. In addition the productivity data at Company A were reported by the department heads, and these records were not open to scrutiny by the researchers. Security considerations at that company

prohibited a double check by outside observers. In contrast the productivity data at Company C were tightly controlled by the researchers. The company's data collection method was refined, and the data appeared to reflect normal operating conditions. The Company C productivity data were relatively stable during the study and over the previous one year period. This data is thus believed to have a high degree of internal consistency.

External Validity

The primary limitations with regard to external validity are the sample size taken and the restricted time period of the study. Both of these limitations were induced by the time and funding parameters of this study. The sample size was too small for the results to be widely generalized. A sample size of at least 35 pairs in each major category of mediating variables is needed to establish the relationships of the independent and descriptive variables to productivity. Similarly, the time frame of the study is too short to seriously test the impact of quality circles intervention on productivity or mediating variables. Most studies on programs of this nature are conducted over at least a one year time frame. In Japan quality circles have been active for two decades, and it is the long term impact and viability of quality circles in U.S. manufacturing companies which should be studied in the next phase of research.

On the other hand, the pairs studied represented a broad range of types of manufacturing companies which are typical in

the U.S. The white collar groups in this study were performing purchasing, scheduling, data processing, drafting, accounting, record keeping, etc. and are typical of most manufacturing companies in the U.S. and to some extent government. These employment classifications represent a large and growing proportion of the U.S. labor force. The blue collar groups at Company B were typical of large batch manufacturing, while at Company C they were largely machine operators and piece workers like those found in the garment industry and many others. The Company D, electronic assembly groups are representative of another large category of industry. A broader representation could be achieved by choosing companies from each of the major Standard Industrial Classifications (SIC).

Observational Vs. Empirical Data

A large amount of observational data were used to identify conditions which maximize the effectiveness of quality circles for increasing productivity. These include interview data and the eight scale Job Reaction Questionnaire administered to the employees. This survey is a perceptual test of management-employee interaction patterns and should not be confused with actual quantitative measures of management behaviour. The eight scales taken together represent a general appraisal of management's performance through the eyes of the employees. Nevertheless, employees' perceptions are often considered significant ends in themselves, and they do give some objective indication of

management behaviour. This survey has been widely used and validated by Honeywell as described in Appendix C.

The interview data were collected by two interviewers making it somewhat more credible. The consistency of responses in the interview data also increases confidence in the data results.

METHODS OF ANALYSIS

All the data were coded and used to create a machine readable data file. The Statistical Package for the Social Sciences (SPSS) was utilized for the analyses. The data were then analysed using the following methods:

1. Descriptive statistics were computed for the dependent variable, productivity, and all mediating variables. They were classified by company and experiment/control group. Charts and tables of these results are presented and discussed in the Results section and Appendix B, C and D. The means and standard deviations of each variable for test and control groups were computed by company. In addition, the mean, standard deviation and sample size were compared between test and control groups for significant differences.
2. The productivity changes and pre-test/post-test JQR score changes were subjected to a two tailed T-test for significant variation between test and control groups. The specific hypotheses thereby tested were the main hypothesis and the first mediating variable hypothesis described in this report in the methodology section above. The T-statistic, degrees of freedom and significance level were calculated as part of the analysis.

Multiple Regression Analysis

Using SPSS, a series of regression analyses was carried out on each mediating variable against productivity for all groups in the study. Pearson correlation

coefficients were used due to the small sample sizes and the mixture of nominal, rank order and interval data in the study. The analyses were conducted sequentially, and then in multiple form, in an attempt to isolate those variables showing significant relationships to the dependent variable of productivity. Multiple regression coefficients and significance levels were produced for each series of variables in the study. The regressions were carried out across all of the paired control and experimental groups according to the following procedure:

1. The productivity changes were regressed against the company variables to control for organization and structural company differences which may or may not be related to the intervention. For example, companies varied in their general productivity trends as well as the nature of the work performed. This variable was therefore used primarily as a control; however, any significant variations may also indicate differences between white and blue collar work situations since the white collar pairs were from Company A, and the blue collar pairs were from Company C.

2. Next productivity changes were regressed against the independent variable of presence of QC's in each of the companies included in step 1 to

determine the relationship of this variable to productivity changes across all QC's groups studied.

3. Each of the descriptive mediating variables in subset 1 and 2, were step-wise regressed against productivity change to isolate any significant relationships. This methodology resulted in the ability to step-wise test each of the mediating variable hypotheses set forth in the conceptual framework section above. Regression coefficients and statistics were generated for each of these regressions using the SPSS data analysis program. Regression coefficients were considered significant if $p < .05$. This was the criteria for rejecting the null hypothesis or accepting a correlation as significant. The regression was run at T_1 and T_2 only, since insufficient data were available at T_3.

Analysis of Variance

An anlysis of the variance (ANOVA) was also carried out for each of the first and second subsets of descriptive mediating variables with respect to change in productivity using the SPSS program. This was done to confirm the results of the regression analyses.

Interview/Observations

Interview data were compiled on each quality circle and consistent reappearing trends were reported. These data were

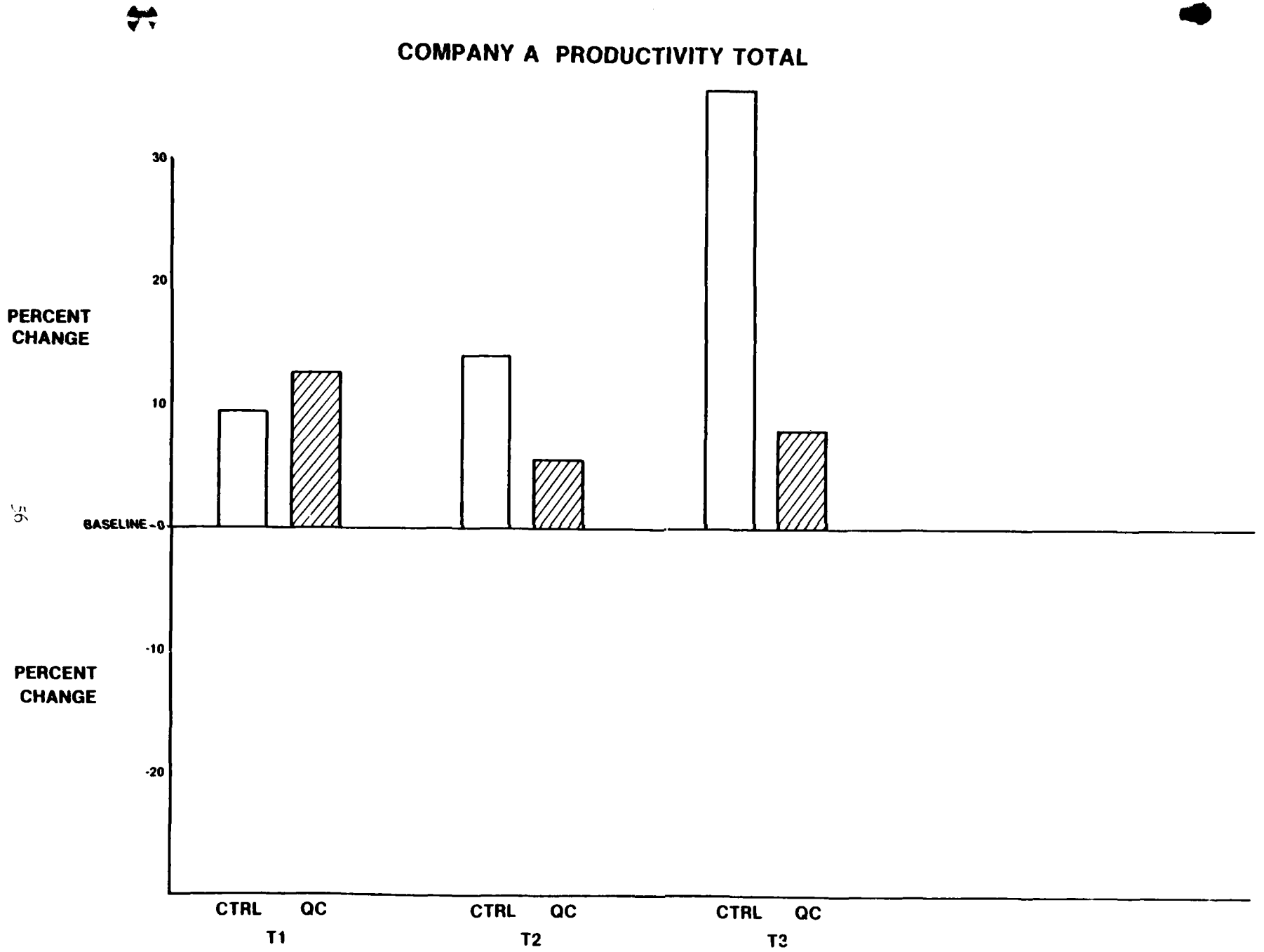
analyzed for evidence confirming or contradicting the mediating variables hypotheses. A description which suggests new mediating variables is also reported at the end of the results section.

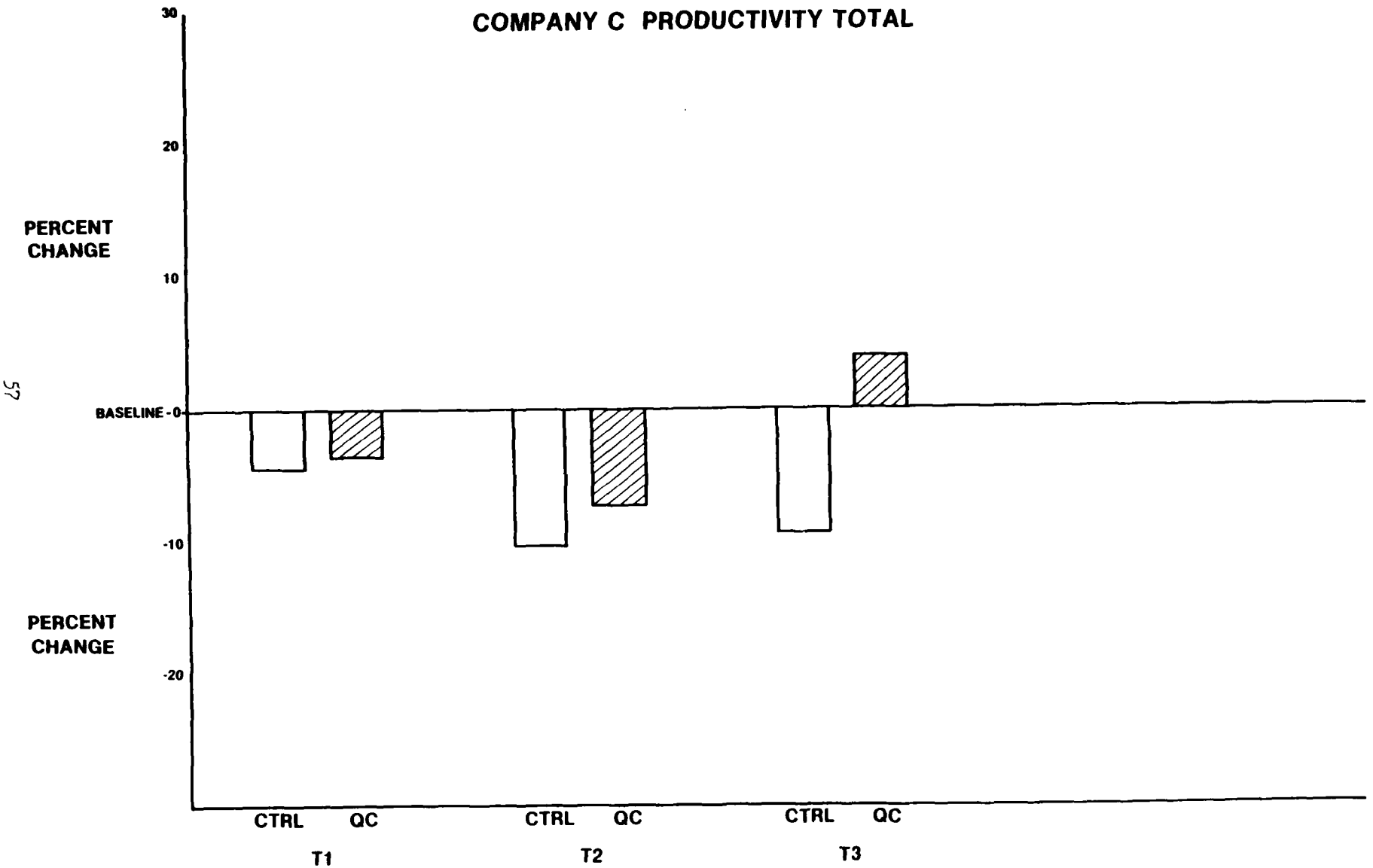
RESULTS

Dependent Variable Productivity Relationships

No significant differences in productivity were detected in the quality circles compared to the control groups during the 10-15 week post-test time period of this phase of the study (see Table 1). The probability (p) value is much higher than the .05 criteria for statistical significance. Despite the lack of significance on the T-tests, a measurable and consistent difference in productivity between the quality circles and control groups is seen in Company C (see Chart on p. 57 and Tables 1-3, Appendix A). At Company C the quality circles decreased in productivity less in T_1 and T_2 than the control groups. At T_3 the quality circles increased by 3.8% while the control groups remained 9.6% below the baseline period. This difference of 13.4%, though not statistically significant, does indicate the hypothesized result. The trend is consistent and grew more pronounced as time progressed. If this trend were to continue over a longer time, or if a larger sample size were used, a statistically significant difference could be detected between quality circle groups and control groups.

At Company A the five quality circles measured increased productivity, 7.8%. However, the three control groups measured increased productivity 36.5%. The two departments using quality circles at Company B increased in productivity by 8% and 39%. The control groups decreased productivity by 27% and 17% respectively. At Company D, the two departments


COMPANY A PRODUCTIVITY TOTAL
30
20
PERCENT CHANGE
10
BASELINE - 0
-10
PERCENT CHANGE
-20
CTRL
QC
T1
CTRL
QC
T2
CTRL
QC
T3


COMPANY C PRODUCTIVITY TOTAL
30
20
PERCENT CHANGE
10
BASELINE - 0
-10
PERCENT CHANGE
-20
CTRL
QC
CTRL
QC
CTRL
QC
T1
T2
T3

which had consistent data and were using quality circles also experienced changes in productivity. One department increased productivity by 6% after three months and 13% after six months. The other department decreased productivity by 11% after three months and 15% after six months. The decreases in productivity of the latter department may have been caused by unusual scheduling problems. The changes were not significant, and the Company B and D data were not included in the T-Test analysis, Table 1, for reasons discussed in the data collection section.

There are several reasons why this result occurred. The first reason is that the short time interval between pre-test and post-test data collection did not provide adequate time for the quality circles to impact the recorded measures of productivity used. Such changes were unlikely to occur in the short time period of the study. Interview data revealed that most of the circles had not yet implemented any solutions to major problems, although many had just received management approval to do so. Significant improvements in productivity were projected from these recommendations.

A second reason for the nonsignificance of changes in productivity was small sample sizes. In Table 1 the degrees of freedom are equal to N-1. Thus for T_1, N=7; for T_2, N=6; and for T_3, N=5. Only very large changes would have been significant with this small sample size.

A third reason for the lack of significant difference between test and control groups was unusual procedural changes that were made by management during

the study at Company A in a department affecting Pairs 5-7. These changes caused sudden dramatic increases in the measured productivity of the control groups at Company A at T_2 and at T_3 (see chart p.56). This historical bias created abnormal conditions, which appear to have overridden the effect of quality circles. It may be argued that these historical changes affected the quality circle groups, as well as the control groups at Company A. However, it is not known exactly how the changes affected each group. It appears that the procedure changes were not uniform across the groups. The large change in productivity of the control groups in Company A at T_2 and T_3 is particularly suspect in this regard.

A fourth reason for the lack of statistical significance is the large standard deviations in the data, as shown on Tables 1-3 Appendix B. These fluctuations suggest that variables which were not measured or controlled had a major influence on productivity, possibly greater than that of the quality circles. Therefore, an even longer time period and a larger sample are needed to show the effects of the quality circles independent from other influences.

TABLE 1
T-TESTS RESULTS FOR PERCENT CHANGE IN PRODUCTIVITY
AT THREE TIME INTERVALS

	Time 1	Time 2	Time 3 Company A	Time 3* Co. A & C
t=	.61	-.08	-1.42	.28
df=	6	5	1	4
p=	.563	.94	.39	ns

* T3 originally included only two pairs from Company A. However, data from 3 pairs at Company C were later added.

Descriptive Mediating Variables

Subset 1: Management-Employee Interaction Patterns

The T-Test resulted in the conclusion that no significant changes on any of the eight management-employee interaction variables could be found between quality circles and control groups (Appendix C). However, the raw scores showed improvements in the quality circles as compared to controls on three scales at Company A and B and six scales at Company C and D. Control groups did not improve on any of the scales more than the quality circles except on task significance at Company A. Charts C1-9 Appendix C and Table 2, page 61 show that management communication and job satisfaction improved more in quality circles than control groups at every company. Personal influence and management communication are closely associated with participative management. Thus, these results support the hypothesis that quality circles increase participative management. In addition to the above gains at Company C, the quality circle groups also increased in job knowledge, cooperation and perceived task significance while the control groups decreased. Company B quality circles also improved on work efficiency. At Company D additional improvements were seen on task significance and cooperation. No real changes were discernible in the areas of work efficiency at Companies A or C or on recognition/feedback at any company.

TABLE 2
PERCENT CHANGE IN MANAGEMENT-EMPLOYEE INTERACTION PATTERNS

	QC	Control	Difference
	Company A		
Work Efficiency	-3%	-10%	7%
Cooperation	-6	-6	0
Mgt. Communication	13	-16	29
Personal Influence	4	-4	8
Use of Job Knowledge	-3	-3	0
Task Significance	-5	36	-41
Recognition	3	-1	4
Job Satisfaction	6	-13	19
	Company B		
Work Efficiency	11%	0	11%
Cooperation	-3	-6	3
Mgt. Communication	7	-6	1
Personal Influence	-3	0	-3
Use of Job Knowledge	0	-8	8
Task Significance	0	2.5	-2.5
Recognition	-11	3	-14
Job Satisfaction	21	-10	31
	Company C		
Work Efficiency	12%	-4%	16%
Cooperation	7	0	7
Mgt. Communication	28	3	25
Personal Influence	16	-4	20
Use of Job Knowledge	6	-5	11
Task Significance	22	-5	27
Recognition	7	3	4
Job Satisfaction	13	-3	16
	Company D		
Work Efficiency	0%	-4%	4%
Cooperation	8	-3.5	11.5
Mgt. Communication	19	0	19
Personal Influence	13	-8	21
Use of Job knowledge	0	-3	3
Task Significance	14	-3	17
Recognition	0	-4	4
Job Satisfaction	6.5	3	3.5

Many of the factors affecting the productivity data also affected this survey data. The short time frame and small sample size are again possible reasons why the results were not statistically significant. The work efficiency and recognition scales would probably increase after quality circle changes were implemented. The interview data revealed that the quality circle members felt it was too early for them to be recognized, since the quality circles had not yet had the opportunity to make major contributions. However, the large number of changes in the predicted direction is encouraging and leads us to postulate that a statistically significant improvement will be found in future research, provided this pilot study is expanded in scope and extended in time.

Management-Employee Interaction Patterns as Mediating Variables

As mediating variables between quality circles and productivity, only one of the eight scales, task significance, was significantly correlated with productivity using multiple regression analysis. This analysis produced the following significant multiple regression results for percentage changes in productivity:

Table 3

Time, T_1

	b	beta	SE
Company A or C	-8.4*	-0.57	3.1
Presence of QC	-0.25	-0.01	6.3
Task Significance	19.7*	0.44	9.6

*Significance Level p=0.05

R^2 =0.34

n=16

constant=54.9

Time, T_2

	b	beta	SE
Company A or C	- 9.3	-5.7	3.6
Presence of QC	- 5.5	-0.17	7.3
Task Significance	27.8	0.51	10.4

*Significance Level p=0.05

R^2 =0.39

n=14

constant= -67.9

This data is interpreted to show moderate intercompany effects but no experimental effects. The presence of Q.C.'s does not have a significant relationship, either positive or negative to change in productivity. However, task significance has emerged as having a significant positive

effect on productivity at T_1 and even stronger positive effect at T_2. Taking all of the variables of Company A or C, QC presence, and task significance into account resulted in multiple correlation coefficients of 0.34 at T_1 and 0.39 at T_2. This is a moderate, but statistically significant correlation. This finding leads us to conclude that perceived task significance is descriptive of one of the conditions which maximize productivity improvement. However, it is not clear that perceived task significance interacts demonstrably with quality circles. At least part of the above correlation is probably accounted for by the improvements in productivity and task significance achieved by the control groups at Company A.

Analysis of Variance

The analysis of variance on each variable in subset 1 and 2 indicated no significant effect on any of the variables. This result was anticipated, since the changes in productivity were not regarded as significant.

Descriptive Mediating Variables- Subset 2

As with the other seven management-employee interaction scales above, none of the second subset of mediating variables were significantly correlated with productivity change. Again, the small sample, N=16, is one reason statistical significance was not achieved. However, unlike the dependent variable and the first subset of mediating variables, there are few descriptive statistics which suggest that a

relationship might be found by further investigation. The interview/observational data, however, do suggest that relationships might be found on some of these variables.

Interview/Observational Results

White Collar/Blue Collar

The productivity of white collar, blue collar, and union quality circles could not be statistically internally compared. This was because the circles in each of these categories were in different companies and because different productivity measures were taken. However, the white collar circles in Company A increased productivity more than the blue collar circles in Company C, but not more than their paired control groups. The blue collar circles show a more consistent trend toward improved productivity and management-employee interaction patterns compared to the controls than the white collar circles.

Observational data indicated that the white collar circles had stronger leadership, were better organized, and were somewhat more enthusiastic than blue collar circles. In addition, they had progressed further toward implementation of solutions to problems since many of the white collar circles had been operating three to four weeks longer than the blue collar circles. Some blue collar circles had difficulty with communication due to foreign language speaking members, variations in reading and writing ability, and inexperience in addressing groups and leading meetings. These difficulties were largely overcome by the blue collar circles during the time period of the study, but they were not a problem for any of the white collar circles.

There are two hypothesized explanations for why the white collar circles in Company A improved less compared to control

groups than the blue collar circles. First, the white collar control groups at Company A increased productivity dramatically due to historical bias as previously discussed. Second, the quality circle problem solving methodology was not as new to some of the white collar groups as it was to the blue collar groups. Thus, the quality circles format may have required less change in style of operation of the work group. Secondly, and related to this, the management of many of the white collar groups was already actively encouraging participative problem solving activity. Thus quality circles did not require as dramatic a change in management style for the white collar circles, as it did for the blue collar circles.

These findings may or may not be generalized to other white collar and blue collar situations. It appeared to be a trend in this study by observation, but not in every case. A better measure of the contribution made by the white collar circles, compared to blue collar circles, will be possible when the solutions to problems generated by all the circles have been implemented.

Union Versus Non-union

The unionized circle members at Company D improved on the majority of management-employee interaction patterns tested using the Job Reaction Questionnaire, while non-circle members generally declined slightly (see Table 2, p. 61). Interview data collected at Company D suggests that the presence of the union

somewhat hinders the quality circles. However, the hindrance was thought to be minor, partly because the union is perceived as being nonaggressive. It was felt by the facilitator at Company D that a stronger union would have presented more difficulties for the circles.

Demographics/Technology

The second subset of mediating variables do not seem to be correlated with productivity. However, it is difficult to say that they do not influence the effectiveness of quality circles based on the limited data in the study. It is possible that a larger sample would reveal correlations.

The expectation was to find such correlations especially between productivity improvement and education and productivity improvement and type of technology. It appears that quality circles do not depend on these factors. If substantiated by a larger study, this will be an important finding, since the argument has been advanced that the high level of math education of the Japanese labor force, relative to the U.S., allows them to make better use of statistical, mathematical, quality control techniques in quality circles[19]. Sophisticated quality control techniques (specifically scatter diagrams and histograms) did not lay a major role in the quality circles in this study. Simple data collection analysis, including control charts,

19. Robert E. Cole, Work Mobility and Participation: A Comparative Study of American and Japanese Industry, (Univer. of Calif. Press,1979), p. 139.

graphs and pareto diagrams were employed and appeared to have been useful in identifying the causes of the problems. Creative group techniques, including brain storming, were used to generate the solutions to problems. Neither a strong mathematics background, nor the use of sophisticated statistical analysis by quality circles, may therefore be a significant condition for improvement of productivity. However, separate control groups would be needed to test the use of different techniques by the various quality circles.

The lack of results on the technology variable also suggests that the type of manufacturing or the labor content in production does not play a role in determining the utility of quality circles. Neither age, length of employment, nor job experience is apparently a factor either. The older and younger groups were equally enthusiastic about quality circles. Group size did not seem to matter with respect to effective group functioning, although the larger groups had more manpower and more ideas than the small groups.

New Variables

Several variables which seem to influence the success of quality circles were identified by observation. These include support from all levels of management, the capabilities of the facilitator, the type and quality of training received by the circle leaders, and the use of incentives.

1. Management Support

Lack of support by all levels of management is cited most

often as the reason quality circles programs fail[20]. Since most of the activity of quality circles is performed by foremen and employees, support by middle and upper management is essential. Sometimes this support, however, is only partial and therefore does not encourage or facilitate the quality circle activities.

Signs of support or lack thereof, such as recognition of achievements by top management, were monitored through interviews. At the time of implementation of the programs, management support was at best mixed in all three companies. Middle managers whose involvement in the program was low, were most often the people who were not supportive of the programs. At the post-test time period management support had improved considerably. While support was dominant, it was not uniform for several reasons. It was observed that there was a lack of involvement of middle and upper managers in the program. This was caused in part by the lack of an active role for the managers in the program. The managers may have felt slighted because the quality circles were receiving attention and training instead of themselves. Therefore, their reaction was often that the quality circles training was not useful to them. This is unfortunate since the techniques, particularly regarding group dynamics, are applicable at all levels of management. Most of the circles leaders felt that higher management should also receive the quality circles training.

20. Robert E. Cole, "Will QC Circles Work in the U.S.?" Quality Progress, pp. 30-33, July 1980.

The above underscores a major difference between the way the quality control movement occurred in Japan and the way quality circles programs are typically started in the U.S. In Japan the highest management was trained in quality control techniques first and then everyone else was trained in a top-down manner[21]. In the U.S. the implementation of quality circles is usually at the level of the foreman or first line supervisor. Middle and upper management are thus bypassed and often do not have an appreciation for how the quality circles operate. They are therefore not in a good position to assist the foremen/supervisors in running quality circles. The circle leaders must depend on the facilitator outside the department, which may be perceived as a loss of control by line managers. It is hard for management to be supportive of something they do not understand well. A seminar was given for the managers at each company at the time of training of the quality circle leaders. However, the seminars, did not provide the middle managers with an active role in the program. Since support from management is an important condition for successful quality circle activity, a solution to this problem must be found.

The solution employed at Company C was undoubtedly the most effective technique used in this study. Due to a perceived need for greater support and involvement from middle management at Company C, the facilitator, unbeknownst to the

21. J.M. Juran, "Japanese and Western Quality- A contrast,"Quality Progress, Vol. 11, No. 12, Dec. 1978, pp.10-17.

researchers, initiated a quality circle in which 10-14 department heads were the members. The circle was instantly successful and improved support for the program by the department heads dramatically. The department heads began attending and participating in the meetings of the quality circles in their departments as many as three levels of management below them. They gave recognition to employees and praised the circles work while in attendance at the meetings. This innovation of management quality circles may provide the missing element for involvement of upper management. At the same time it is a powerful tool to spread the benefits of quality circles to upper management where lack of communication, cooperation and productivity is a problem of greater consequence than that of the shop floor. The success of the management quality circle at Company C also raises the possibility of implementing quality circles using a top down approach. This might further help to eliminate the above problems of lack of management support.

2. The In-House Facilitator

In nearly every quality circles program there is a full or part-time facilitator or coordinator who is a manager in the company. The facilitator attends most of the quality circles meetings as an advisor and interfaces with management on behalf of the quality circles. It is widely felt that the facilitator's own personal capabilities are critical to the success or failure of quality circles programs. Business Innovations worked closely with the companies to select the

facilitators. Each facilitator had strong interpersonal abilities and commanded credibility and respect at all levels of the organization.They were selected very carefully with deliberation and evaluation of their qualifications.

In all three companies, Business Innovations worked closely with the facilitator and observed their performance while working with management and employees. The facilitators in all three companies met and surpassed the above qualifications and were undoubtedly very important in the success of the quality circles program in each case. Thus, this variable was held constant in this study. A condition for success of significant management talent must be devoted to the quality circles program in the form of a facilitator to maximize the effectiveness of the program.

3. Training

According to Dr. Juran, training is the key to successful quality circles. The Q.C. circles movement in Japan was achieved through a massive training effort which took a decade to complete[22]. These training programs generally focus on creative problem solving, information gathering and group behaviour. In Japan greater emphasis was placed on statistical techniques of quality control.

In the U.S. companies which introduce quality circles in a serious way generally get professional assistance for training programs. In this study the training variable was held

22. J.M. Juran, "Japanese and Western Quality_ A Contrast," Quality Progress, Vol. II, No. 12, pp. 10-17, Dec. 1978.

constant. A training format provided by a leading consulting firm in quality control circles, Productivity Development Systems, was used. The professional consultant/trainers from outside the companies generally trained an in-house facilitator, so the company would have its own expert after the consultant left. However, not all quality circle leaders receive such professional training. Even the training which is available varies widely. The effect of U.S. variations on the training that occurred in Japan is not known. Nor has much experimentation with further training modifications been done. In fact so little company training is aimed at the employee level in the U.S., there is inadequate knowledge of what effect further training would have. It is also possible that additional training in statistics, group dynamics or industrial engineering techniques would enhance the success of quality circles.

4. Incentives/Recognition

Many Japanese companies and U.S. companies give cash rewards to quality circles for documented improvements which reduce costs or increase productivity. The form of the incentives varies considerably. In our study only Company C opted for an incentive program. This was accomplished simply by enlarging the existing suggestion system to include recommendations made by QC's. The existing suggestion program with cash rewards was made available to the quality circles under the same rules as it was for individuals. The bonuses were not large, and it did not appear to have been an

important motivational factor. It was not mentioned in any interviews, although the circles at Company C had not yet made any applications for rewards. Incentive programs may have a larger effect if cash rewards are more significant. There is some evidence cited by researchers that gainsharing programs interact with quality circles to improve productivity more than either program above[23]. Company A has a similar program giving recognition, but no cash rewards. Several circles at Company A who had projected savings from problems they had solved were very eager to make applications to be recognized via the program. Formal recognition programs may be a causal variable in continued motivation and success of quality circles.

Many circles interviewed felt that it was too early for them to receive formal recognition for their quality circle contributions. However, those circles which had developed major work improvement ideas were clearly motivated by the informal recognition they were already receiving from higher management. This variable was tested to some degree by the recognition scale in the JRQ.

---

23. Mitchell Fein, Personal interview, Mitchel Fein Assn., June 1982.

DISCUSSION

Productivity

The results of this study indicate that it is probable that a positive effect on productivity resulting from quality circles will be found in further research. It has not been significant so far in this study because of the short time period, the small sample size and the large standard deviations. The lack of statistical significance of changes i n productivity was not unexpected. In spite of the above, at Company C a consistent trend is identifiable; the productivity of the quality circles was higher than the same measure for the control groups in T_1 and T_2 and T_3. Also, in Company C consistently larger improvement in all eight measures of management-employee interaction patterns was found for the quality circles compared to the control groups. The results at Company B also support the main hypothesis, although this data is less reliable.

The most accurate and reliable productivity data were obtained at Company C, because an individual incentive system was in place. It allowed close tracking of 75% to 95% of the work output of each person in the study, whereas the productivity data at Company A reflects historical bias due to unusual events. In addition the productivity data from Company A measured less uniform units of output, than those at Company C. Productivity measurement was generally more difficult for white collar groups than blue. This leads us to place greater confidence in the data from Company C than any other company, which supports the main hypothesis.

It is remarkable that even this much difference showed up in such a short period of time. At Company C where the post-test data were collected about 10 weeks after quality circle training and installation, none of the quality circles had yet implemented any major changes in work design or procedures. Therefore, the improvements in productivity of quality circles there did not come from solutions to problems implemented by the quality circles. The changes in productivity must therefore have resulted from improved motivation, attitude, communication, cooperation, etc., rather than from specific innovations. This conclusion further supports the hypothesis that management-employee interaction patterns are mediating variables in improving productivity. In future research it should be possible to track the productivity improvements resulting from management-employee interaction improvements, as distinct from innovations and other factors, through recording historically the dates of the implementation of specific innovations.

Mediating Variables Influencing Productivity And Quality Circles

This section describes conditions which maximize productivity gains when quality circles are present. It deals with variables tested in the study and identifies new variables which were discovered during the study.

The management-employee interaction patterns tested in the study appear to improve as a result of

quality circles, though not as yet significantly. The most consistent of these improvement patterns were management communications, job satisfaction and increased personal influence of employees. Improvements on the management communications and personal influence scores indicate a change toward a more participative style of management and an increase of information in the system. These changes have been important objectives of management scientists, since participative management was first proposed in the 1960's. If these changes are sustained over a long period of time, then quality circles must be considered to be a major contribution to management science as a technique to accomplish organizational development objectives. Often these changes are viable management objectives whether or not they improve productivity in the short run. None of the tested management-employee patterns were significantly correlated with productivity except task significance. However, we would expect to see greater improvement over a longer period of time and more significant correlations of the JRQ measures, especially the above three.

A high pre-test score on the JRQ scales was expected to correlate with the success of the quality circles increasing productivity. No such correlations were found. In fact the company with the lowest pre-test scores, Company C, showed the most consistent

improvements in productivity and management-employee interaction patterns. The scales covering communication and personal influence are considered indicative of the degree to which participatory management is practised. Based on these results, we conclude that the pre-existence of participatory management does not affect the success of quality circles. However, it is likely that the quality circles program will cause greater use of participatory management, and this may maximize the effectiveness of quality circles.

It may even be that participatory management is more important to productivity improvement than quality circles as observed in the following case. During the study period a control group in Company A implemented a production change of the same type the quality circles were formulating. That group increased productivity more than any quality circle or control group in the study. These improvements were caused by the implementation of a procedure change suggested by the group members whose management had been encouraging a participative problem solving activity for some time. The group did not have the structure of a quality circle, yet it practiced the same type of participative problem solving activity as circles do. One conclusion which can be drawn from this finding is that strong management encouragement for participative problem solving may occasionally result in productivity

improvement of a similar magnitude and type to those associated with quality circles. Another conclusion that can be drawn is that when the quality circles have had an opportunity to implement some of their recommendations, as this one control group did, then a significant improvement in productivity may occur.

Task significance is one employee perception which is statistically correlated with productivity improvement in this study. The test groups did not improve significantly on the task significance measure except at Company C. However, interviews, circles members stated repeatedly that a major benefit of quality circles was a greater awareness of the importance of their jobs to the company and to other departments. This effect was present mainly in several quality circles which were solving problems which required meetings with or collection of data from departments other than their own. A way to influence perceived task significance may therefore be based on the degree to which the quality circles initiate interactive problem solving with departments outside their own. Five circles in this study were working to solve problems in conjunction with other interacting departments. This interdepartmental activity would logically serve to increase the awareness of circle members of the significance of their work to other people.

There was much discussion from managers of external influences on the productivity of the departments. It was the opinion of the managers that scheduling, sales, long range

work cycles, changes in systems, personnel, weather, etc., were influencing productvity more than anything the employees could control. These influences may account for the large standard deviations in the productivity data.

These factors affecting demand appeared to be out of the control of the work groups, and the work groups did not appear to be able to respond to these short term events in ways that maintained high levels of productivity. The responsibility would appear to be with management rather than employee level/group members for controlling or responding to these external influences. This observation corresponds with Deming's statement that 85% of the factors affecting productivity are controlled by management. This observation suggests that efforts to improve productivity should be encouraged at the management level, even more than the employee level, where quality circles usually operate. There are many possible strategies to achieve better short-term adjustments or control of factors influencing productivity, but one way which appears to have much promise is quality circles or productivity oriented teams involving management. This solution in which the heads of several interfacing departments were circle members seemed to be working well at Company C, as discussed earlier. The quality circle concept at the management level increases current information levels and improves interdepartmental coordination which could increase productivity more than anything employees can influence.

Of the above influences affecting productivity demand for

output seemed to be the most significant factor from an observational point of view. The groups appeared to work harder, rearrange priorities, and/or change procedures to maximize output in response to short term high demand situations. Sometimes this shift appeared to be at the expense of high quality. Conversely, productivity fell when demand was reduced which occurred due to scheduling delays, materials delays or low sales. This solution seemed to be working well at Company C. It is also possible to postulate that a perceived demand increases perceived task significance when the task is performed in response to the demand. Support for this hypothesis is evidenced by the fact that the control groups at Company A which were pressured by high demand at Company A increased on task significance dramatically and also in productivity at T_3.

RECOMMENDATIONS

One of the main purposes of Phase I of this research was to test the feasibility of the approach. This section discusses the merits and weaknesses of the approach used in Phase I, and recommends some changes for the second phase of the study.

The greatest challenge in Phase I was completing the study within the seven month time frame of the DESAT Program. We recommend an expanded time frame for study of the long term effects of quality circles of at least 1-5 years. Quality circles were a long range strategy in Japan (they have been

active for over 20 years there) and should be evaluated as such in the U.S. In the U.S. business has been criticized for favoring short term results over long term investment in people, equipment and product development. The long term effects of quality circles may be more dramatic than we yet realize, or they may be a fad which will die out in the U.S. Long term study of quality circles in the U.S. is needed to discover which result is most likely to occur, and more importantly, why. The circles which have been started in this study should continue to be monitored for at least one year, and additional circles and control groups at least 35 in each category to be studied should be initiated. Twenty-five is the minimum sample size generally required for results to be obtained which have a high degree of external validity. More types of work situations should be studied, especially unionized situations.

The problems encountered with the approach used in this study are as follows:

1. Difficulty finding adequately controlled situations in companies wishing to start quality circles at the time of the start of the study. This problem can be eliminated with adequate lead time, and incentives to companies for participation. Large corporations tend to make decisions about implementing quality circles slowly.
2. Baseline data especially on white collar areas productivity was inaccurate or unavailable for many work groups. This problem can be addressed by choosing

facilities which have individual incentive systems, or other accurate measures for recording output of identifiable work groups. It is very difficult to measure the productivity of certain white collar work groups. However, many departments such as purchasing, data processing, payroll, scheduling, etc., often have very usable measures of productivity.

3. Historical events influenced productivity greatly, and it is therefore very difficult to obtain unbiased data. A large sample and close continuous monitoring of historical events are the best answers to this problem. We discovered that the data was usable on only about 50% of the original pairs in this study. A higher rate of data retention could probably be obtained through better up-front analysis of available productivity historical data as a basis for projecting the likelihood of disruptions occurring during the study.

4. It was difficult to keep management from expanding the program into control areas, once they were convinced of the value of the quality circles. A strong long term commitment to the study by the company's management is needed.

5. At Company D an alternate approach for studying quality circles already in place was used. The advantages of this approach are that it is less expensive and quicker, because the quality circles which have been operating for a long period of time can be studied immediately. The problems with this approach included lack of available

accurate productivity date, inability to select random samples, and reduced control and monitoring of historical bias.Data obtained by this method may nevertheless be useful when reliability can be established.

6. One of the findings of the study is that "abnormal conditions" were found more frequently in the tested companies than "normal" conditions. Change and uncertainty is so prevalent in business today that stable conditions may no longer be normal. This raises questions about the advisability of discarding "abnormal" or historically biased data. Although unusual events cause large standard deviations in productivity data a large enough sample would presumably cancel out such effects.

In conclusion, the tested approach appears to be feasible for a larger study, but it is difficult to control for the many external factors which affect productivity. Candidate study environments must be thoroughly evaluated and carefully selected before an investment in training is made. A 10-30% loss of data due to uncontrollable events can be expected. About 25 pairs in each category to be tested must be usable after data loss for data analysis. Retrospective study of existing quality circles may be a lower cost, but lower reliability alternative or adjunct approach.

The focus for Phase II of the research in addition to productivity should be the first subset of mediating

of quality circles, and at least one, task significance, is correlated with productivity. A second area where important conditions for maximizing the benefits of quality circles may be found is the method of implementation. Specifically, a top-down approach or more management quality circles should be tried. Also variations on training for the quality circles should be tested. These could include additional training in group dynamics, industrial engineering, statistical analysis, and creativity development techniques. Yet another source of fruitful information would probably result from a study of facilitators characteristics, personality, experience, and relationships with people in the company.

Differences are still expected in white collar vs. blue collar, and union vs. non-union work groups with the following additions. White collar managerial and non-managerial groups should be distinguished. Unions should also be distinguished in terms of aggressiveness. A scale for this purpose could be created using number of strike days in the union's recent history.

The other descriptive mediating variables, including education and type of technology, should continue to be monitored and tested in Phase II. A more specific measure of labor content in the product should be added. However, age, sex, job experience, group size, etc., do not appear at this time to be

important factors in increasing productivity through quality circles.

APPENDICES

APPENDIX A

Data Collection Instruments

The data collection instruments used in the study appear in this appendix and are described below.

1. Company background questionnaire, pp. 89-91.
2. Subunit Data, a data collection instrument describing each work group, pp. 92-96.
3. Individual data questionnaire, the Job Reaction Questionnaire, pp. 97-101.
4. Compilation forms, used to compile the individual data into the group averages, pp. 102-3.

COMPANY BACKGROUND DATA

1. Company name _____

2. Industry _____

3. total # of employees (in this plant/facility)

   January 1, 1981 _____

4. total # of employees (in this plant/facility)

   December 31, 1981 _____

5. # of employees terminated for cause in 1981

   _____

6. # of employees laid off in 1981

   _____

7. # of employees transferred to other plants/facilities of this company in 1981

   _____

8. In what year was this plant/facility established? _____

9. How many functional divisions are there in this plant/facility?

   _____

10. How many levels of hierarchy are there in this plant/facility?

    _____

11. What is the Administration/Production ratio (i.e., # administrative employees/ # production employees)?

    _____

12. What is the absenteeism rate for this plant/facility
    (ask if this rate includes managers)

    _____

13. What is the Company's sick leave policy?

14. What is the Company's vacation policy?
    (e.g. plant closes for vacation, each employee earns X days per year, etc.)

15. How much was spent in 1981 on social and recreational programs: parties, athletic events, equipment, etc. for employees in 1981?

_____

15a. What is the source of this funding?

16. Is there a profit sharing plan for employees?
Describe:

17. Is there a stock purchase option for employees?
Describe:

18. Are employees in this plant/facility represented by one or more labor unions?

yes_____ no_____

18a. Which categories of employees are represented?

18b. How many employees (approximately) of this plant/facility are union members?

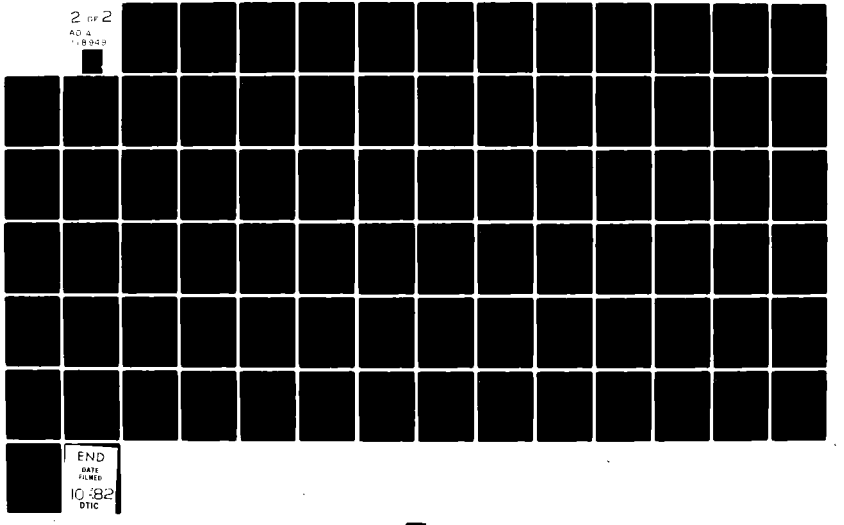
_____

19. Has there been a strike at this plant/facility during the past 5 years?

yes _____ no_____

If "yes" answer questions 19a and 19b; if "no", skip to 19c.

AD-A118 949 BUSINESS INNOVATIONS INC ALEXANDRIA VA F/G 5/9
THE UTILITY OF QUALITY CIRCLES IN UNITED STATES MANUFACTURING C--ETC(U)
JUL 82 S E HARPER, G L JORDAN N00014-82-C-0139
UNCLASSIFIED 4 NL



19a. How many person/work days were lost because of this strike?

_____

19b. How was the strike settled?

19c. When was the last union vote held in this plant/facility?

_____

20. Employee benefits as % of wages and salaries_____

20a. Enumerate employee benefits: (e.g. health insurance, dental benefits, pension plan, etc.)

21. Labor costs as % of total costs of this plant/facility_____

22. Have any QWL (quality of working life) programs been implemented at this plant facility during the past 5 years? (e.g. flexitime, job sharing, job rotation)

yes_____ no_____

Describe each program and the degree of success with each.

23. For which categories of employee, if any, are there written job descriptions?

organizational employees only_____
blue collar employees only _____
non-managerial employees only_____
managerial employees only _____
all employees _____
(other) _____

24. What was the plant/facility's ROI (return on investment) in 1981?

_____

Subunit data - ask Subunit Supervisor/manager

Group I.D.#:_____ (Col. 1-4)

1. How many employees are in this workgroup? _____ (Col. 5-6)

2. How many persons do you supervise directly?_____ (Col. 7-8)

3. How many <u>different</u> job titles are there in this work group/subunit?

_____ (col. 9-10)

4. How many hours did you spend in meetings last week?

_____ (Col. 11-12)

5a. In the production process used in this subunit/department, which of the following six descriptions best applies to the <u>most automatic</u> piece of machinery? (circle the appropriate number in Column A)

	A most automatic piece	B bulk of equipment
a. Hand Tools and Manual Machines (ex. pliers, hammer, files, etc.)	0	0
b. Powered Machines and Tools - muscles are replaced for the basic machine function, but machine action and control are completely dependent on the operator. Uses mechanical power, but a person positions work and machine for desired action (ex. electric tools).	1	1
c. Single-Cycle Automatics and Self-Feeding Machines - completes an action when initiated by an operator. Operator must set-up, load, initiate actions, adjust, and unload. (ex. production machines without necessary automatic control system, grinder, planer, lathe, etc.)	2	2

	A most automatic piece	B bulk of equipment
d. Automatic: Repeats cycle- At this level all energy is mechanized. Carries out routine instructions without aid by persons. Starts cycle and repeats actions automatically-self feeding. Loads, goes trough sequence of operations, unloads to next station or machine. No self-correction but obeys internal program such as cams, tapes or cards. (ex. engine production lines, self-feed press lines, automatic copying lathe, etc.)	3	3
e. Self-Measuring and Self Adjusting - Feedback - measures and compares results to desired state and adjusts to minimize error. Although feedback control of the actual surface of the workpiece is preferable, positional control of the machine table or tools is of great value, too. (Ex: feed-back from product, automatic sizing grinders, size controlled honing machines, process controllers, etc.)	4	4
f. Computer Control: Automatic Cognition - Computer monitors multiple factors on which machine or process performance is predicated - evaluates and reconciles them to determine proper control action.	5	5
	(Col. 13)	(Col. 14)

5b. In the production process used in this Subunit/department, which of the above six descriptions best applies to the bulk of your equipment? (Do not count machines for regulating temperature among automatic machines). (Circle the appropriate number in Column B.)

6. What is the average age of equipment in this department/subunit?

_____ months
(Col. 15-17)

7. What is the average downtime per week of equipment in this department/subunit?

_____ hours
(Col. 18-19)

8. Please circle on the following 7-point scale the extent to which each of these five major technologies is used in your department/subunit.

	This technology is not applicable to principal product(s).	It is used very slightly in the manufacture of principal product(s).	It is used slightly in the manufacture of principal product(s).	It is used moderately in the manufacture of principal product(s).	It is used considerably in the manufacture of principal product(s).	It is used to a great extent in the manufacture of principal product(s).	It is used almost exclusively in the manufacture of principal product(s).	
Custom Technology production or gabrication of a single unit or a few units to customer specifications.	1	2	3	4	5	6	7	(Col. 20)
Small Batch (job shop) Technology production of small batches	1	2	3	4	5	6	7	(Col. 21)
Large Batch Technology production of large batches (ex. of components for subsequent assembly as in a fabricating shop, or of finished products) e.g. bottles, cans, chemicals.	1	2	3	4	5	6	7	(Col. 22)
Mass Production Technology as on as assembly line.	1	2	3	4	5	6	7	(Col. 23)
Continuous Process Technology production of liquids, gases or solid shapes (ex. oil refinery).	1	2	3	4	5	6	7	(Col. 24)

Subunit Data - Productivity

1. What are the principal outputs or products of this subunit?

Ask questions 2 through 11 for several points in time: Dec., 1981, Oct., 1981, and August, 1981 (later in the Spring obtain Feb. and April, 1981 data).

	April 1982	Feb., 1982	Dec., 1981	Oct., 1981	Aug., 1981
2. What was the average daily output for this subunit/workgroup in (Dec., 1981, Oct., 1981, Aug., 1981)?					
3. What was the average hourly output per person during each of those months? (Ascertain whether this figure reflects total output or output passing quality control.)					
4. What was your average downtime per week (for each of the selected months)?					
5. What were your average maintenance costs per hour (during each of these months)?					
6. What was your average first pass yield (i.e. ratio of output passing quality control to total output) for each of these months?					
7. What was your output per material resources (during each of these months)?					

	April, 1982	Feb., 1982	Dec., 1981	Oct., 1981	Aug., 1981
8. Amount of scrap as % of total material resources? (for each of these months)?					
9. Absenteeism rate for this subunit (daily average) for each of these months)?					
Ask questions 10 and 11 for each different type of job performed within the subunit:					
10. Standard hours for job completion (for each of these months) job a					
job b					
job c					
job d					
11. Actual hours for job completion (in this subunit, for each month)					
job a					
job b					
job c					
job d					

12. How many employees have joined this subunit

since August 1, 1981? _____

since October 1, 1981? _____

13. What are the fixed costs per month attributable to the operation of this subunit?

_____

Ask for any other productivity data that are available by subunit or individual employee:

	April, 1982	Feb., 1982	Dec., 1981	Oct., 1981	Aug., 1981
8. Amount of scrap as % of total material resources? (for each of these months)?					
9. Absenteeism rate for this subunit (daily average) for each of these months)?					
Ask questions 10 and 11 for each different type of job performed within the subunit:					
10. Standard hours for job completion (for each of these months) job a					
job b					
job c					
job d					
11. Actual hours for job completion (in this subunit, for each month)					
job a					
job b					
job c					
job d					

12. How many employees have joined this subunit

since August 1, 1981? _____

since October 1, 1981? _____

13. What are the fixed costs per month attributable to the operation of this subunit?

_____

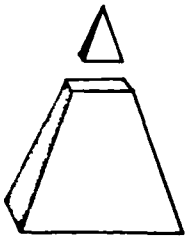
Ask for any other productivity data that are available by subunit or individual employee:

PRODUCTIVITY MEASURES BY WORK GROUP

		Data Collection Points 1 2 3 4 5
1.	Output unit definition per unit of time: _____	
2.	Total output (units/time) of this division: (First pass)	___ ___ ___ ___ ___
3.	Output (units/time) less rejects: (or reject rate)	___ ___ ___ ___ ___
4.	Standard hours for work completion: _____	
5.	Actual hours:	___ ___ ___ ___ ___
6.	Scrap rate:	___ ___ ___ ___ ___
7.	Average daily production down time (hours)	___ ___ ___ ___ ___
8.	Cost of down time ($/hour): _____	
9.	Total overheard/month attributable to this work group (if computable):	___ ___ ___ ___ ___
10.	Cost of material used (per week) (If computable)	___ ___ ___ ___ ___

Additional measures of quality or productivity as available:

	Name of measure:	No. of units/time:
11.	_____	___ ___ ___ ___ ___
12.	_____	___ ___ ___ ___ ___



Business Innovations, Inc.

2413 King Street, Alexandria, Virginia 22301 • (703) 548-1069

FOR CONSULTANT TO READ TO THE WORK GROUPS
WHEN ADMINISTERING INDIVIDUAL QUESTIONNAIRES

A research group from Business Innovations, Inc. in Alexandria, Virginia, in conjunction with The Productivity Group, Austin, Texas, has received a contract from the Federal government to study industrial relations practices and performance in several companies across the country. Your company has agreed to participate in this study.

Please complete the attached questionnaire. The information you provide is strictly confidential: Do not sign your name to the questionnaire. The information obtained from individual employees like yourself will be combined to produce statistics on this company. Only these aggregated data, no individual questionnaries will be made available to this company and to the government agency funding this study. Results of this study will be available in June 1982.

Thank you for your assistance.

Sincerely,

Stephen E. Harper
Principal Investigator

Group I.D.#: _____

1. What is your job title _____

2. List and describe the 4 tasks you perform most often in your job.

_____

_____

_____

_____

3. How many years/months have you been employed by this Company? _____

4. For how many years/months have you been performing this job in this Company?

_____

5. How many different jobs have you held in this Company? _____

6. What is your current hourly wage? (or if you are a salaried employee what is your current weekly salary?)

$_____per_____

7. How many hours a week do you usually work at this job?

_____hours per week

8. In what month did you receive your last salary/wage increase?_____

9. Since you've been employed by this company, have you ever participated in training programs sponsored by the company or taken job-related courses paid for in part or full by this company?

_____yes _____no

9a. Describe these courses or training programs:

10. How many work days have you spent in training programs at this company?

_____

11. Do you belong to a labor union? _____yes _____no

12. What is your age? _____

13. Sex *Male*_____ *Female*_____

14. Education: Circle the number of years of school completed on the following line.

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17+		

We would like your judgement of how much influence each of four groups of company employees: top managers, middle managers, first level supervisors, and non-managerial employees, has on the making of several types of decisions within this company. For each of the seven decisions listed below, indicate in Column A how much say or influence top management has on this type of decision. In column B, indicate how much influence middle management has on each type of decision. In column C, indicate how much influence first level supervisors (e.g. foreman, floor lady, clerical supervisor, other first level supervisor) have in each decision area and in column D, the amount of influence that non-managers have.

Indicate the maount of influence on a 5 point scale, where 5 = a very great deal of say or influence and 1 = little or no say or influence.

very great deal				little or none
5	4	3	2	1

For example, if you think that middle managers have a great deal of influence on a decision area, you would put a "4" in column B for that decision. If you think that non-managerial employees have an intermediate amount of influence in a decision area, you would put a "3" in column D for that decision area.

Decision area	Column A top managers' influence	Column B middle managers' influence	Column C 1st level supervisors' influence	Column D non-Managers' influence
promotion of first line Supervisors				
deciding to produce a new product				
which Suppliers of materials are to be used				
dismissing a first-line Supervisor				
the extent and type of market to be aimed for				
which and how many welfare facilities, programs or benefits (e.g. recreational, health, etc) are to be provided to employees				
creating a new department				

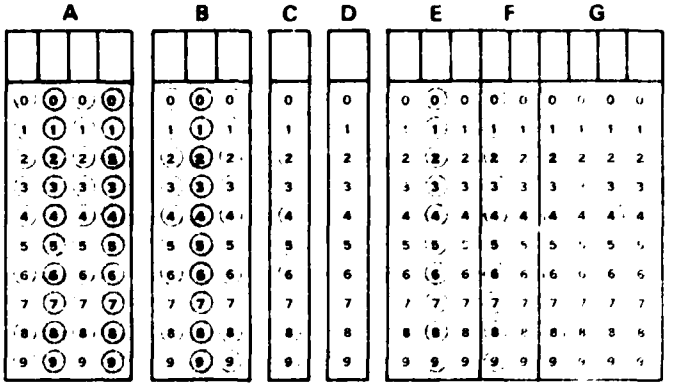
JOB REACTION QUESTIONNAIRE

MARKING DIRECTIONS

Use only a soft black lead pencil (No. 2).
Make heavy black marks that fill the circles completely.
Erase completely any answer you wish to change.
Make no stray marks on this sheet.

PROPER MARK ●

IMPROPER MARKS ✓ X O •



Please be as objective as possible in describing your job, and be honest about your feelings regarding your work.

Indicate how much you agree or disagree with each statement:

Strongly agree — 5
Agree — 4
Neither agree nor disagree — 3
Disagree — 2
Strongly disagree — 1

1. We seldom have delays or foul-ups at work
2. My work group is well organized
3. Meetings to exchange information and ideas are held here pretty often
4. When something at work really bothers me I can usually get some changes made
5. My job gives me a chance to use my talents
6. I know how the parts or products I make will be used
7. I get a lot of information about how well I'm doing on my job
8. Problems here get corrected quickly
9. I feel part of a very efficient organization
10. We get a chance to air out our problems here
11. People like me can get changes made at work if we make ourselves heard
12. This department puts my experience to good use
13. I know what the goals of my work group are
14. When I do really well I find out about it right away
15. We don't have much confusion at work
16. There is a spirit of cooperation between people in different kinds of jobs in the work area
17. When management says we have to live with a problem they usually explain the reasons to our satisfaction
18. My opinion carries weight with the people who make decisions around here
19. My job really makes use of my skills and abilities
20. I know who uses the things I make or the work I do and I feel obligated to them
21. My supervisor criticizes my job performance in a way that helps me improve
22. My work group gets word of changes (rush jobs, change in materials, heavier work load) in plenty of time to prepare for them

Please be as objective as possible in describing your job, and be honest about your feelings regarding your work.

Indicate how much you agree or disagree with each statement.

	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
	1	2	3	4	5

23. Work groups here cooperate to get the job done 1 2 3 4 5

24. Management here acts on employee suggestions 1 2 3 4 5

25. If some rule or policy makes our work harder, we can usually get it changed 1 2 3 4 5

26. I can make good use of my skills because I've been trained in what I am supposed to do 1 2 3 4 5

27. In my job I can identify certain people who use my service or products 1 2 3 4 5

28. When I do well in my job the people I work with tell me so 1 2 3 4 5

29. There's not much waste of materials at work 1 2 3 4 5

30. When other sections can't give my unit proper service we usually find out why 1 2 3 4 5

31. When employees are asked for their opinions, management makes good use of them 1 2 3 4 5

32. When I have a good idea about how work should be done, people higher up take me seriously 1 2 3 4 5

33. I am taught new things which increase my job knowledge and confidence 1 2 3 4 5

34. I know how my job affects people on other jobs 1 2 3 4 5

35. My boss usually recognizes when I do good work and tells me so 1 2 3 4 5

36. We plan ahead for problems that might arise 1 2 3 4 5

37. When we need help from another section or function, they follow through without delay or complaint 1 2 3 4 5

38. When employees make suggestions here, things get done 1 2 3 4 5

39. You can get to the right people here to get things done 1 2 3 4 5

40. Learning and training are part of the game here 1 2 3 4 5

41. It is clear to me what is expected of me on my job 1 2 3 4 5

42. If I perform well on my job I will be recognized for my contributions 1 2 3 4 5

43. Considering everything, I'm satisfied with this job 1 2 3 4 5

44. I think that efficiency and productivity could be improved here 1 2 3 4 5

GROUP AGGREGATE OF INDIVIDUAL DATA

Card #: 1 (Col.1)

Group ID#: _ _ _ _ (Col. 2-5)
Group ID#: _ _ _ _ (repeat) (Col. 6-9)

Q1, Q2 Job codes: (to be determined)

1.	%:_____	(Col. 10-11)
2.	%:_____	(Col. 12-13)
3.	%:_____	(Col. 14-15)
4.	%:_____	(Col. 16-17)
5.	%:_____	(Col. 18-19)
6.	%:_____	(Col. 20-21)
7.	%:_____	(Col. 22-23)
8.	%:_____	(Col. 24-25)
9. Missing	%:_____	(Col. 26-27)

Q1, Q2 % of group doing white collar work: _____% (Col. 28-29)
Q1, Q2 % of group doing blue collar work: _____% (Col. 30-31)

Q3 Mean # of months employed by company:_____ (Col. 32-34)

Q4 Mean # of months performing same job:_____ (Col. 35-37)

Q5 Mean # of different jobs at company: _____ (Col. 38-40)

Q6 Mean hourly wage: _ _ . _ _ (Col. 41-44)
(If weekly wage given, divide by Q7 to get hourly wage.)

Q7 Mean hours worked per week: _ _ . _ (Col. 45-47)

Q8 Mean # of months since last raise: _ _ . _ (Col. 48-50)

Jan. 1982 = 1	May 1981 = 9
Dec. 1981 = 2	Apr. 1981 = 10
Nov. 1981 = 3	Mar. 1981 = 11
Oct. 1981 = 4	Feb. 1981 = 12
Sept. 1981= 5	Jan. 1981 = 13
Aug. 1981 = 6	Dec. 1980 = 14
July 1981 = 7	Nov. 1980 = 15
June 1981 = 8	Oct. 1980 = 16

Q9 Training: % _____ _____ (Col. 51-52)
(Note: look at 9a to make sure that the QC training is not the only training listed. If it is, count as "no.")

Q10	Mean work days spent in training: __ __ . __	(Col. 53-55)
Q11	% belonging to labor union: __ __ __	(Col. 56-58)
Q12	Mean age: __ __ . __	(Col. 59-61)
Q13	% Male: __ __	(Col. 62-63)
Q14	Mean years of education: __ __ . __	(Col. 64-66)

APPRENDIX B

Productivity Tables

This appendix contains three tables, on productivity changes, averaged and broken down by company and experimental/control groups. There is one table for each time interval T_1, T_2, T_3.

TABLE B1

MEAN CHANGE IN PRODUCTIVITY AT FIRST TIME INTERVAL, T_1

BY COMPANY AND BY QC/CONTROL

Company	A	B	C
Control			
x	9.5	-21.5	-4.5
sd	18.3	4.5	6.8
n	3	2	4
Q.C.			
x	12.4	19.5	-3.8
sd	17.8	19.5	10.9
n	5	2	4

Interpretation: No significant differences, but increases at Company A in both ixperimental and control groups and small insignificant decreases at C are seen. There is so much variation in the groups and the sample size is so small that the changes araea not be statistically significant.

TABLE B2

MEAN CHANGE IN PRODUCTIVITY AT SECOND TIME INTERVAL, T_2
BY COMPANY AND BY QC/CONTROL

Company	A	B	C
Control			
x	13.8	-27	-10.5
sd	6.1	--	15.3
n	3	1	3
Q.C.			
x	5.6	8	6.2
sd	22.0	--	3.5
n	5	1	3

Interpretation: No significant differences are shown. The productivity of experimental groups at Company A increased less than that of the control groups. However, the standard deviation is so high that this cannot be regarded as indicative of a trend. Experimental groups at Company C decreased in productivity less than control groups, as they did at T_1.

The control group at Company B has not changed significantly since T_1. This reflects a constant product mix between T_1 and T_2. The QC group at Company B gained slightly in productivity over T_1 and the baseline. The product mix was constant over these three time periods.

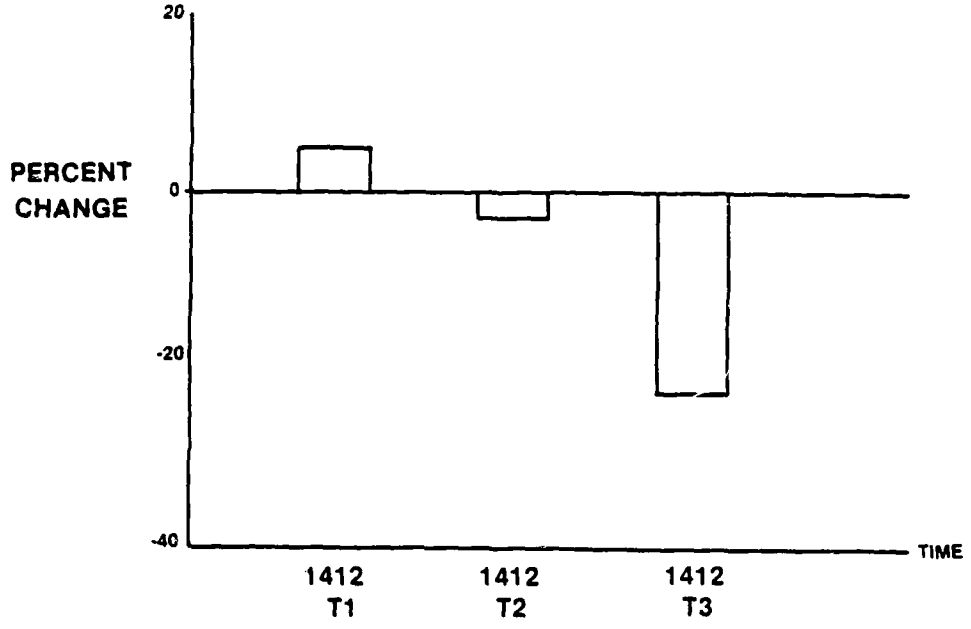
TABLE B3

MEAN CHANGE IN PRODUCTIVITY AT THIRD TIME INTERVAL, T_3, BY COMPANY AND QC/CONTROL

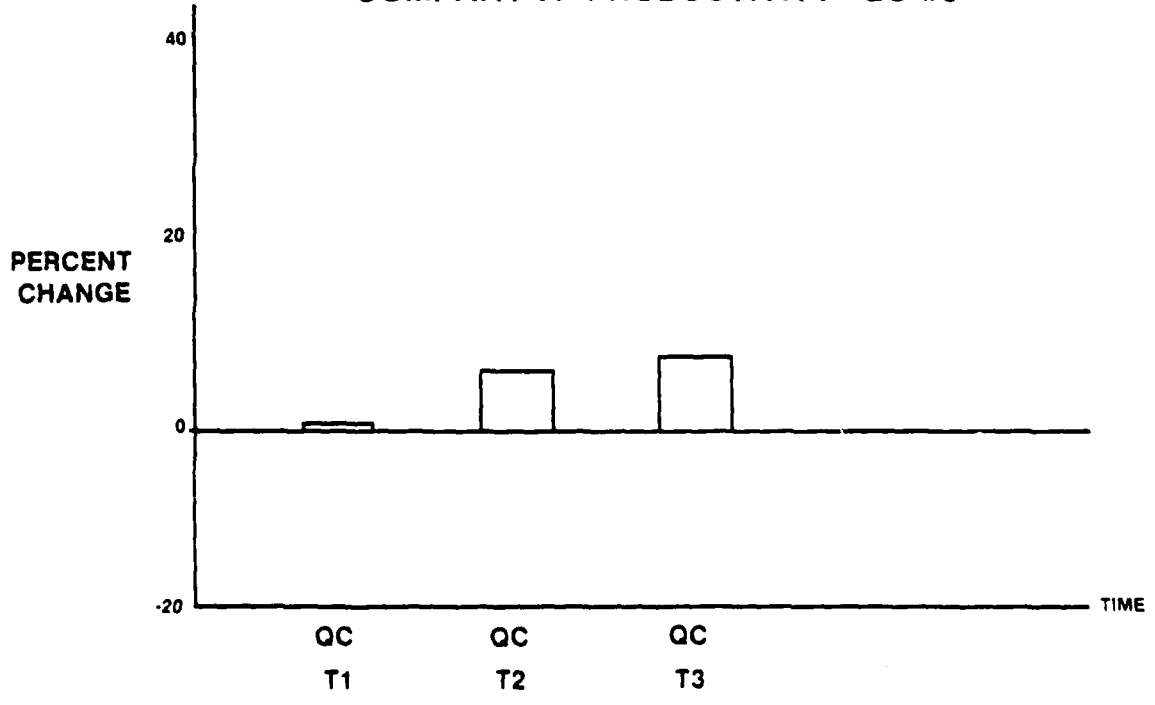
COMPANY	A	C
Control		
x	36.5	-9.6
sd	3.5	16.0
n	2	3
Q.C.		
x	7.8	3.8
sd	23.4	3.9
n	4	3

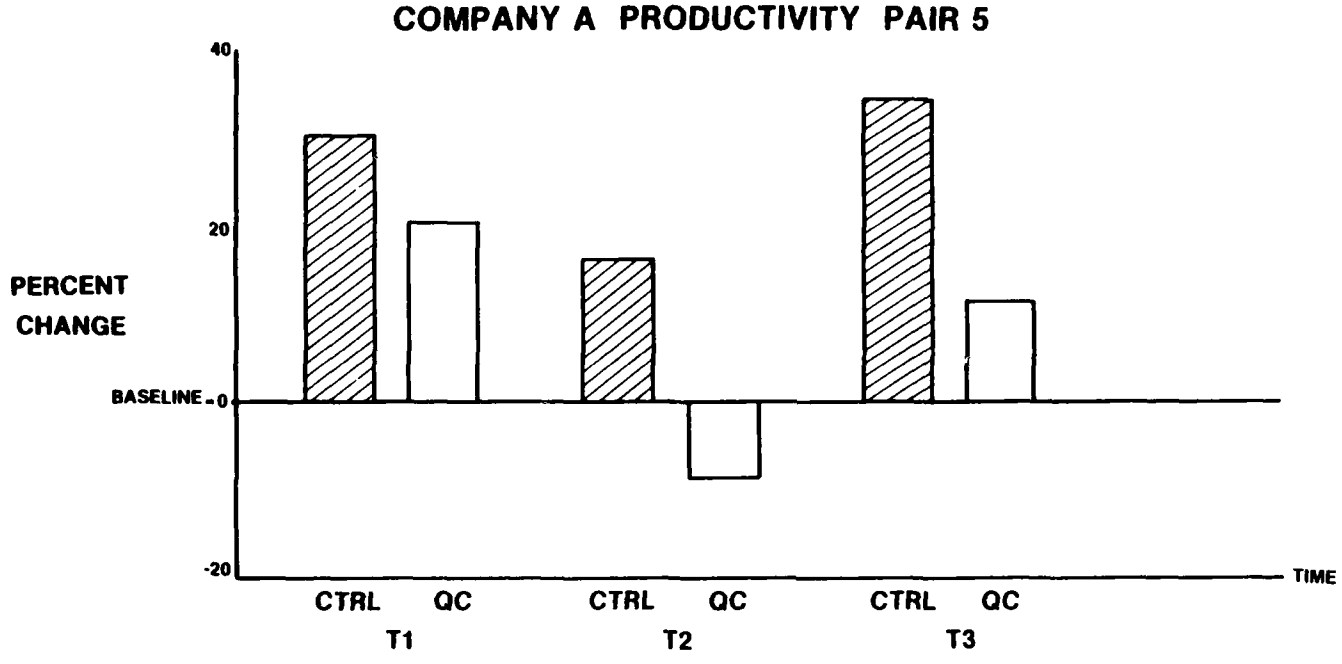
Interpretation: Productivity of the control groups at Company A were influenced by procedure and policy changes. Company C experimental groups increased in productivity while the control groups' productivity decreased. No data was available for Company B.

COMPANY A PRODUCTIVITY QC #4

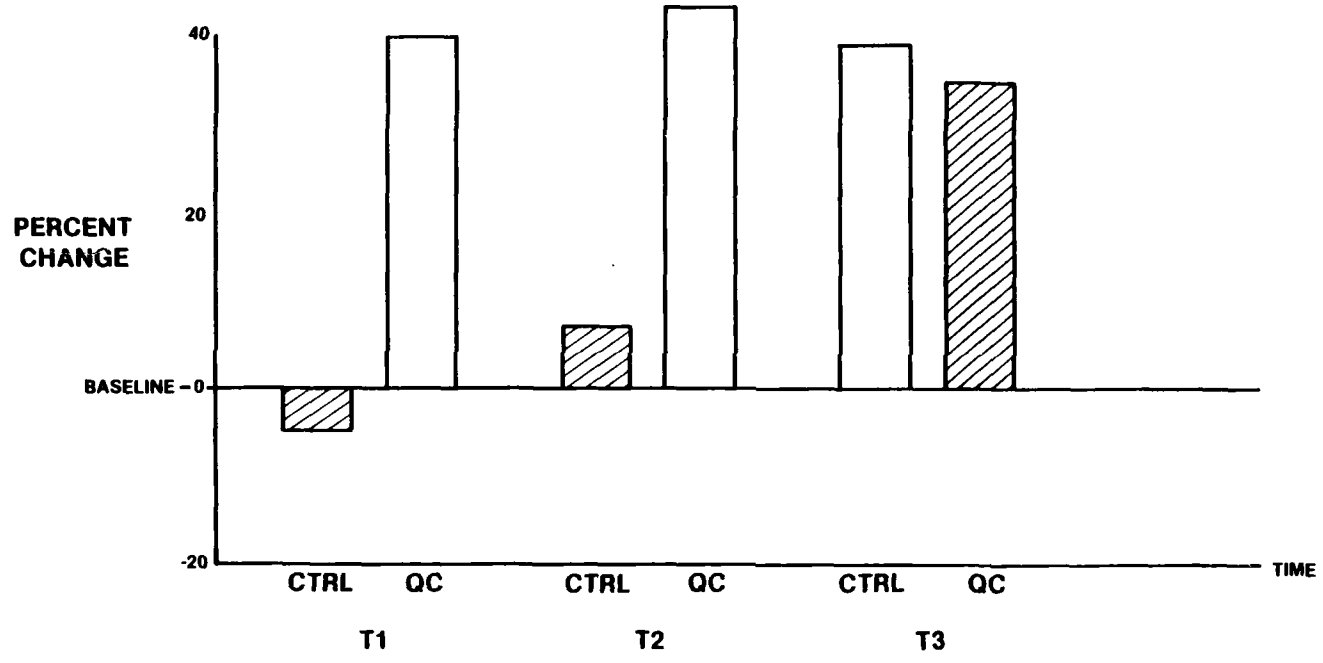


COMPANY A PRODUCTIVITY QC #3

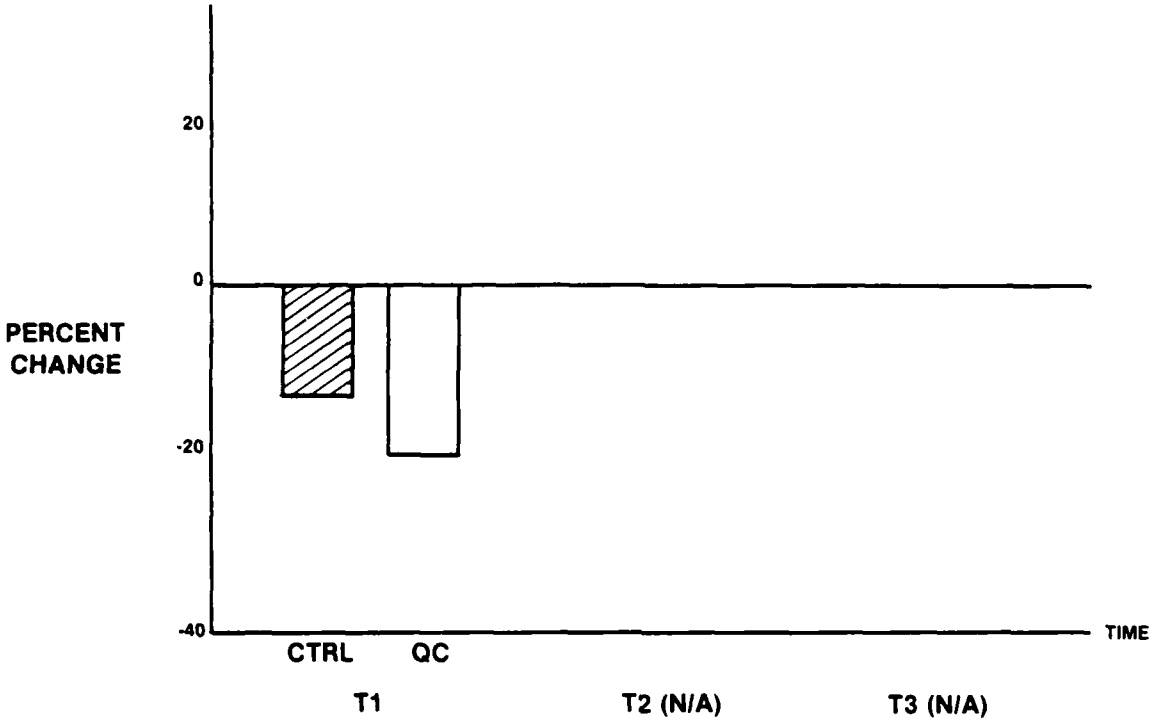



COMPANY A PRODUCTIVITY PAIR 5
40
20
PERCENT
CHANGE
BASELINE - 0
-20
TIME
CTRL
QC
CTRL
QC
CTRL
QC
T1
T2
T3

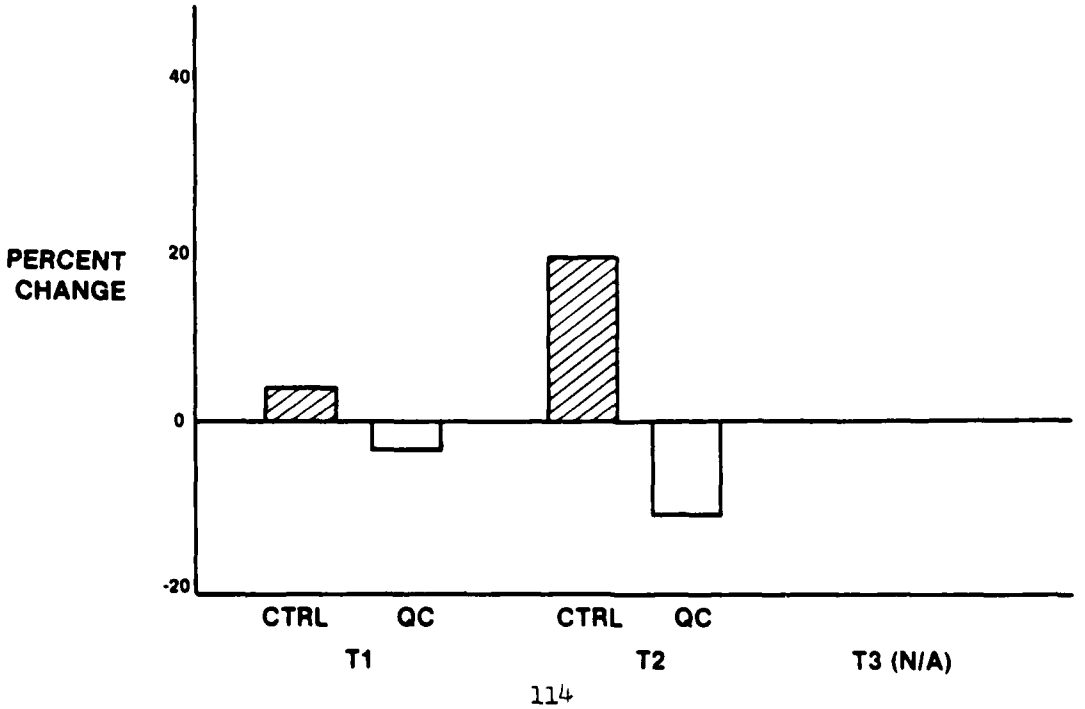
COMPANY A PRODUCTIVITY TOTAL PAIR 6



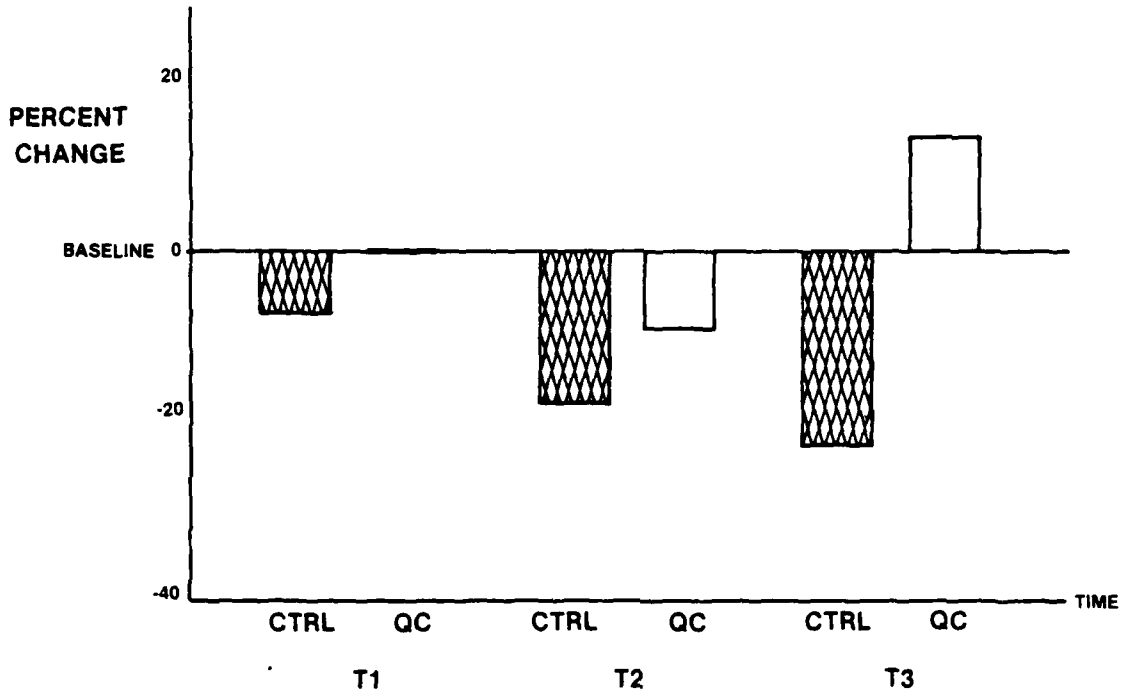
COMPANY C PRODUCTIVITY PAIR 1



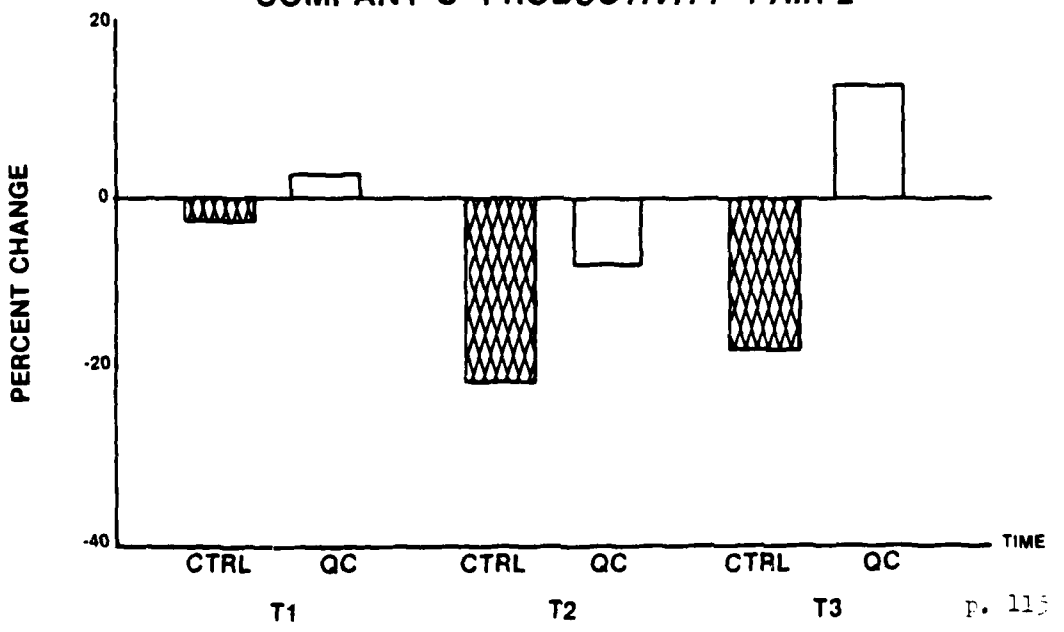
COMPANY A PRODUCTIVITY PAIR 7



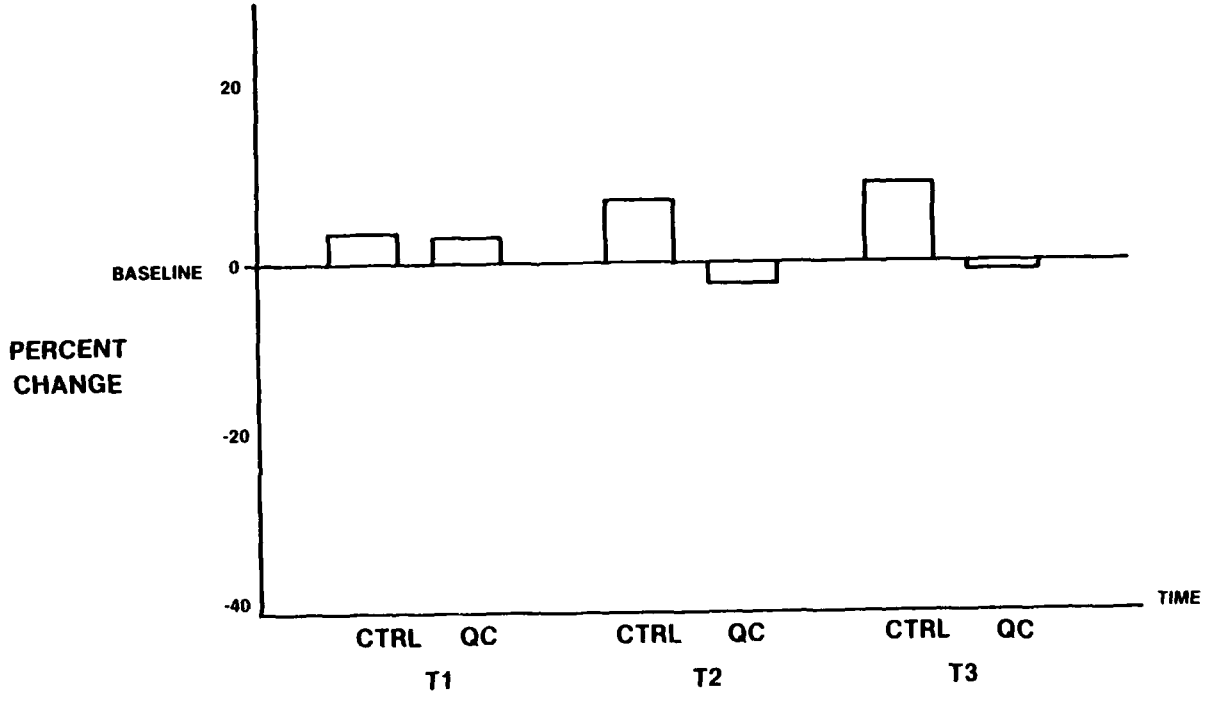
COMPANY C PRODUCTIVITY PAIR 3

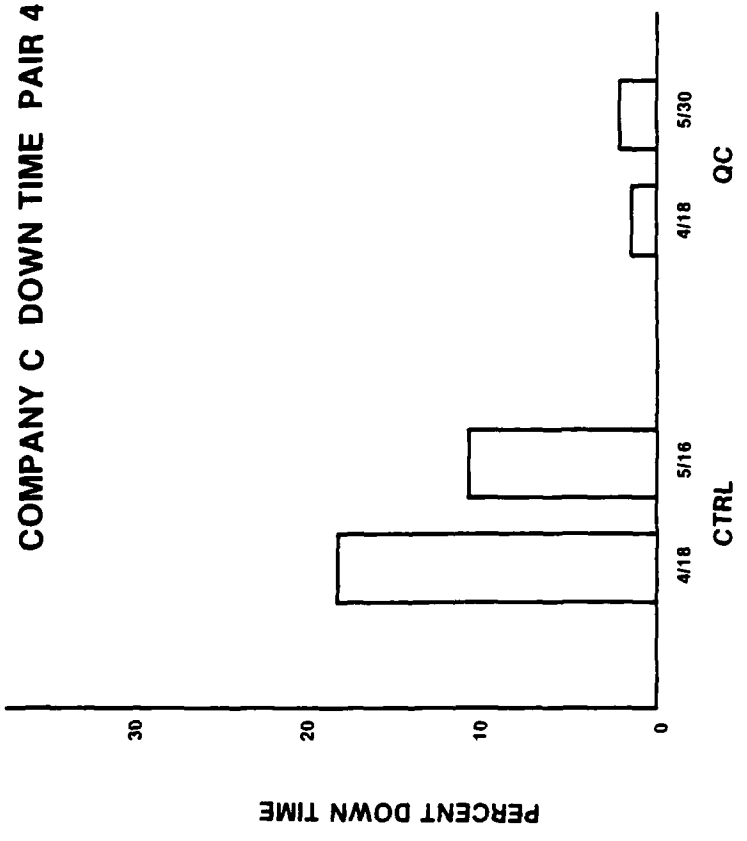


COMPANY C PRODUCTIVITY PAIR 2

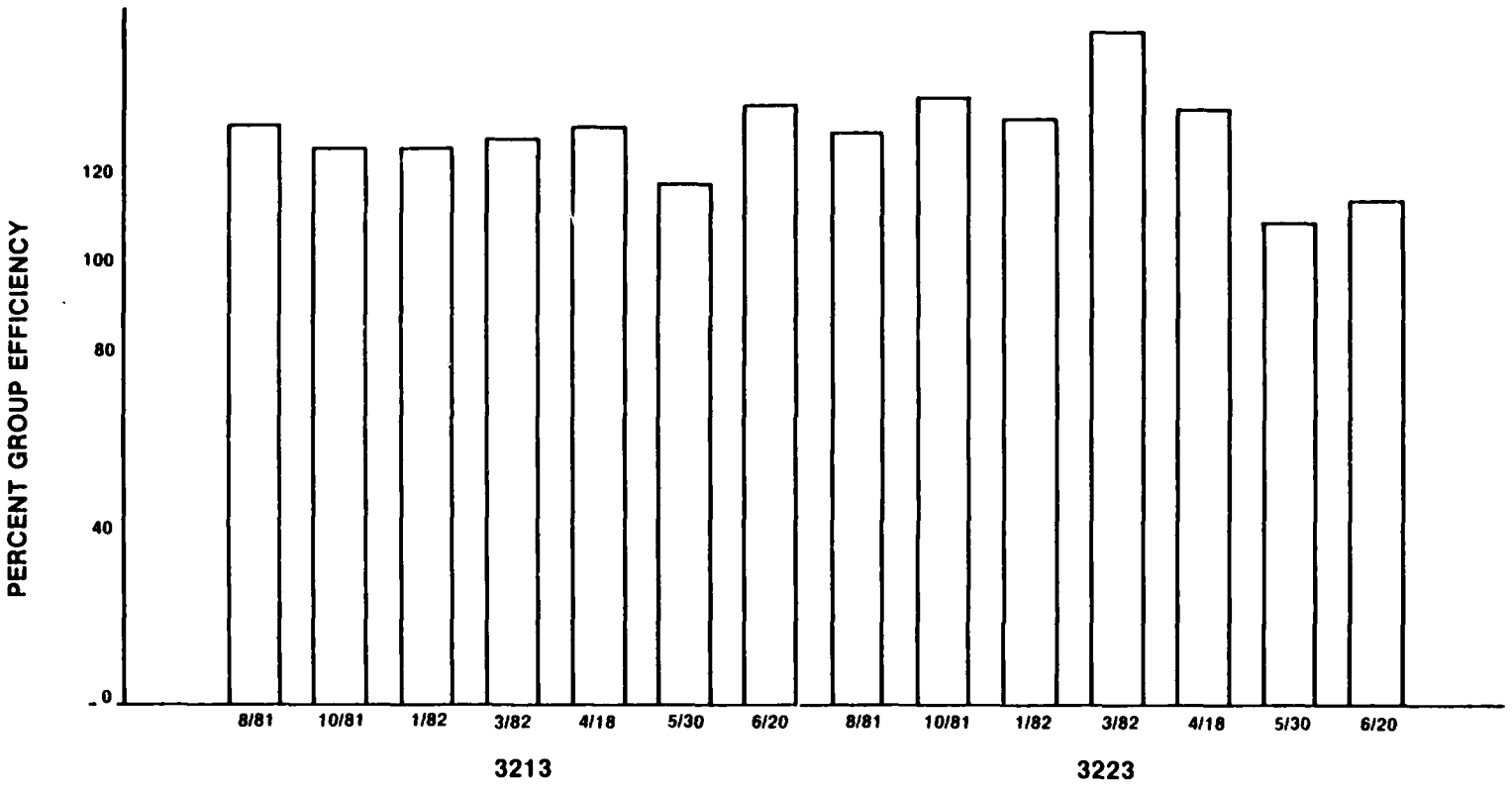


COMPANY C PRODUCTIVITY PAIR 4

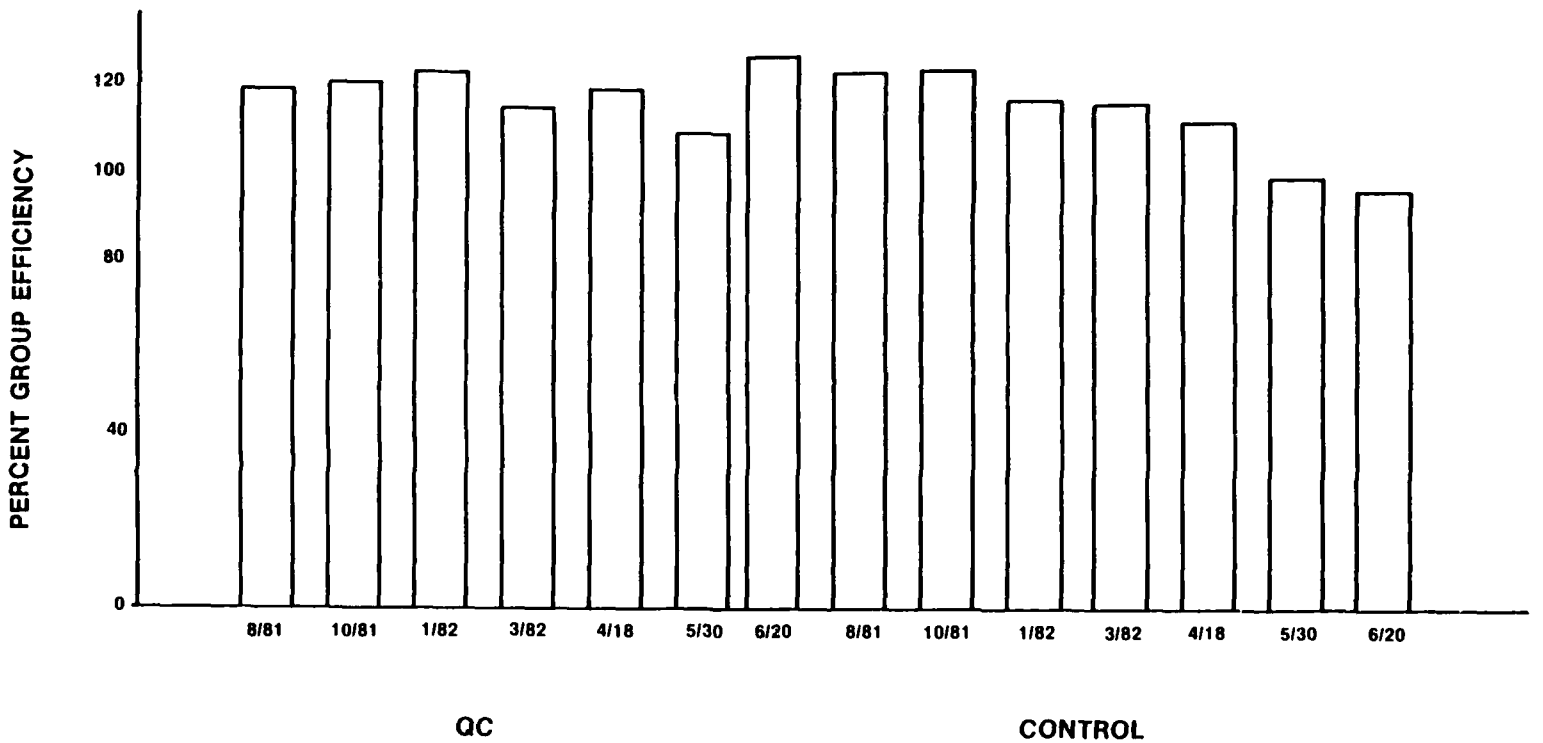



COMPANY C DOWN TIME PAIR 4
PERCENT DOWN TIME
30
20
10
0
4/18
5/16
CTRL
4/18
5/30
QC

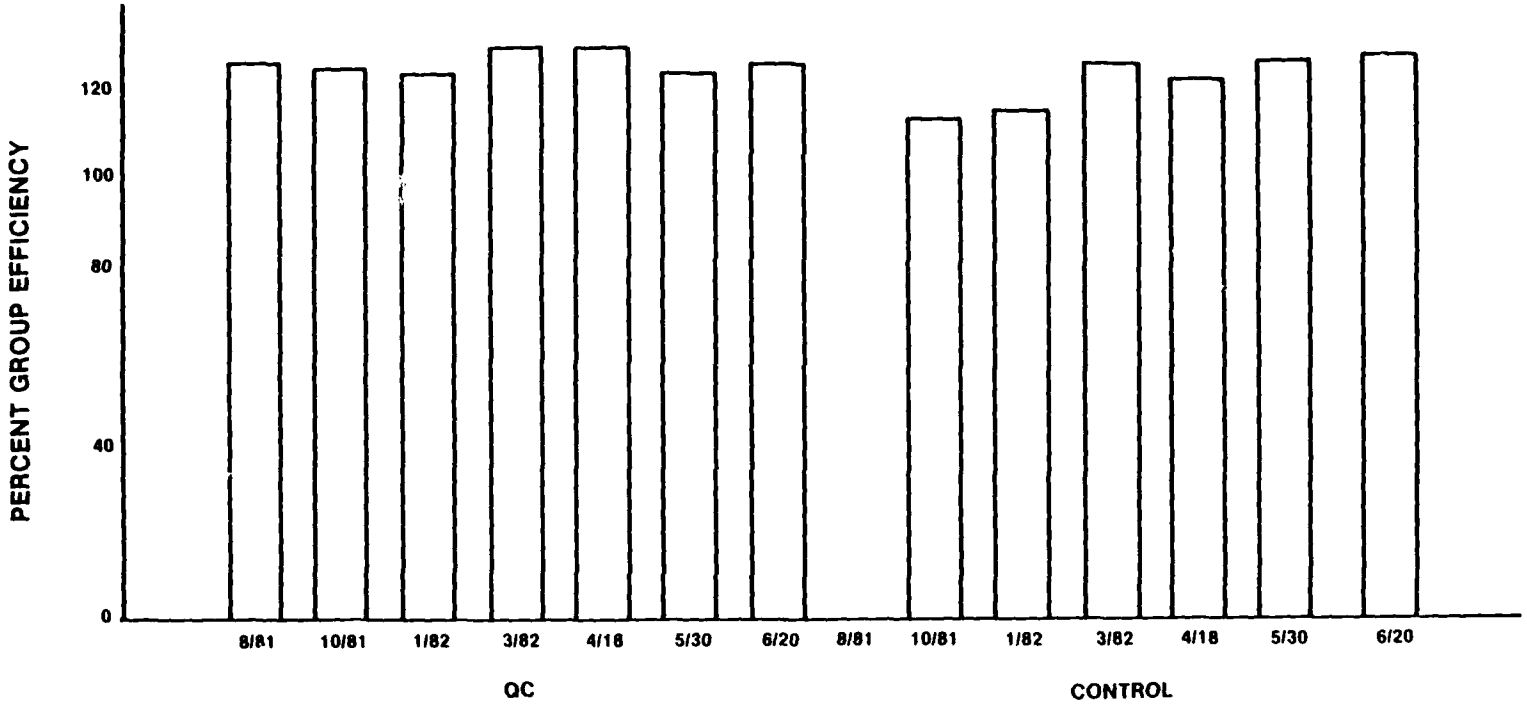
COMPANY C EFFICIENCY PAIR 2

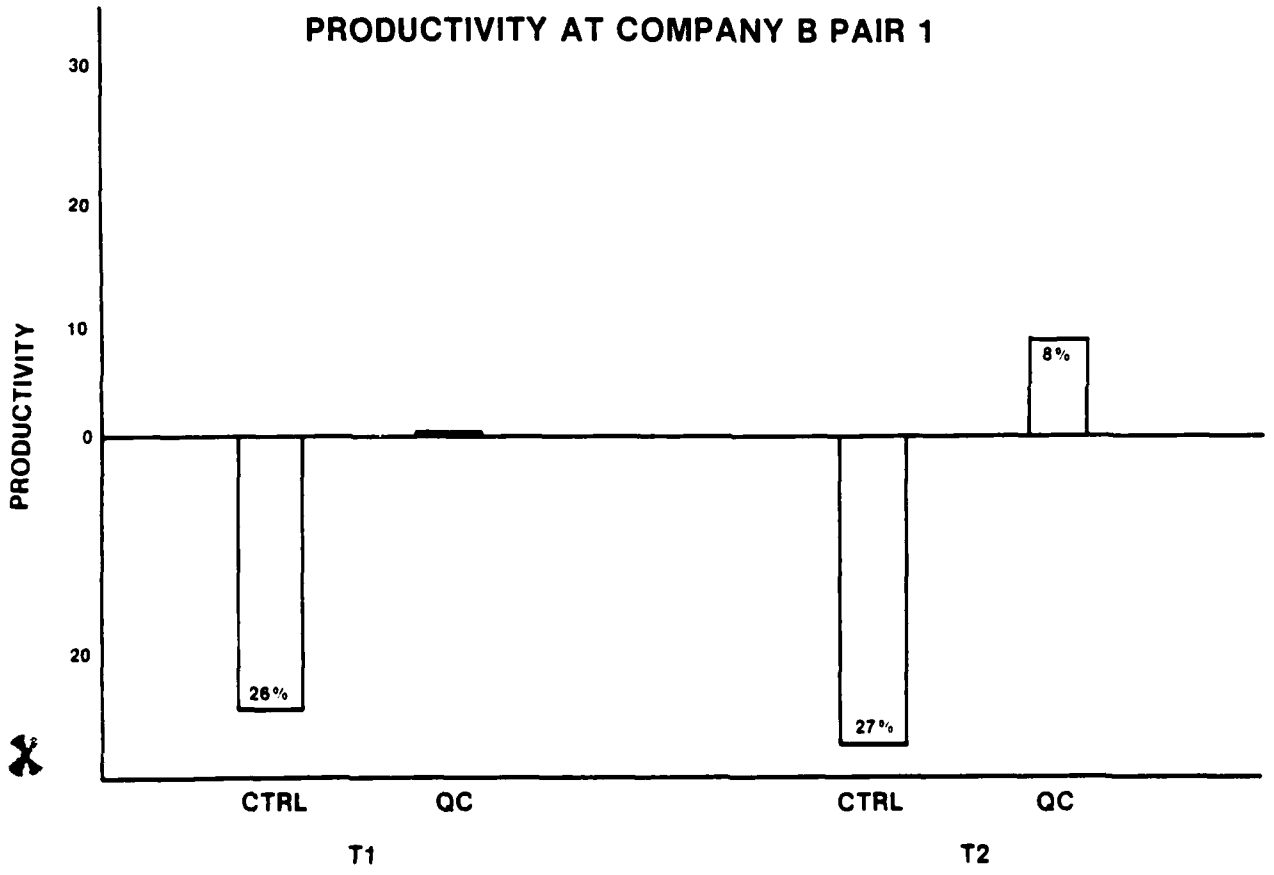


COMPANY C ACTUAL EFFICIENCY AS PER CENT OF STANDARD OUTPUT/MAN HOUR PAIR 3

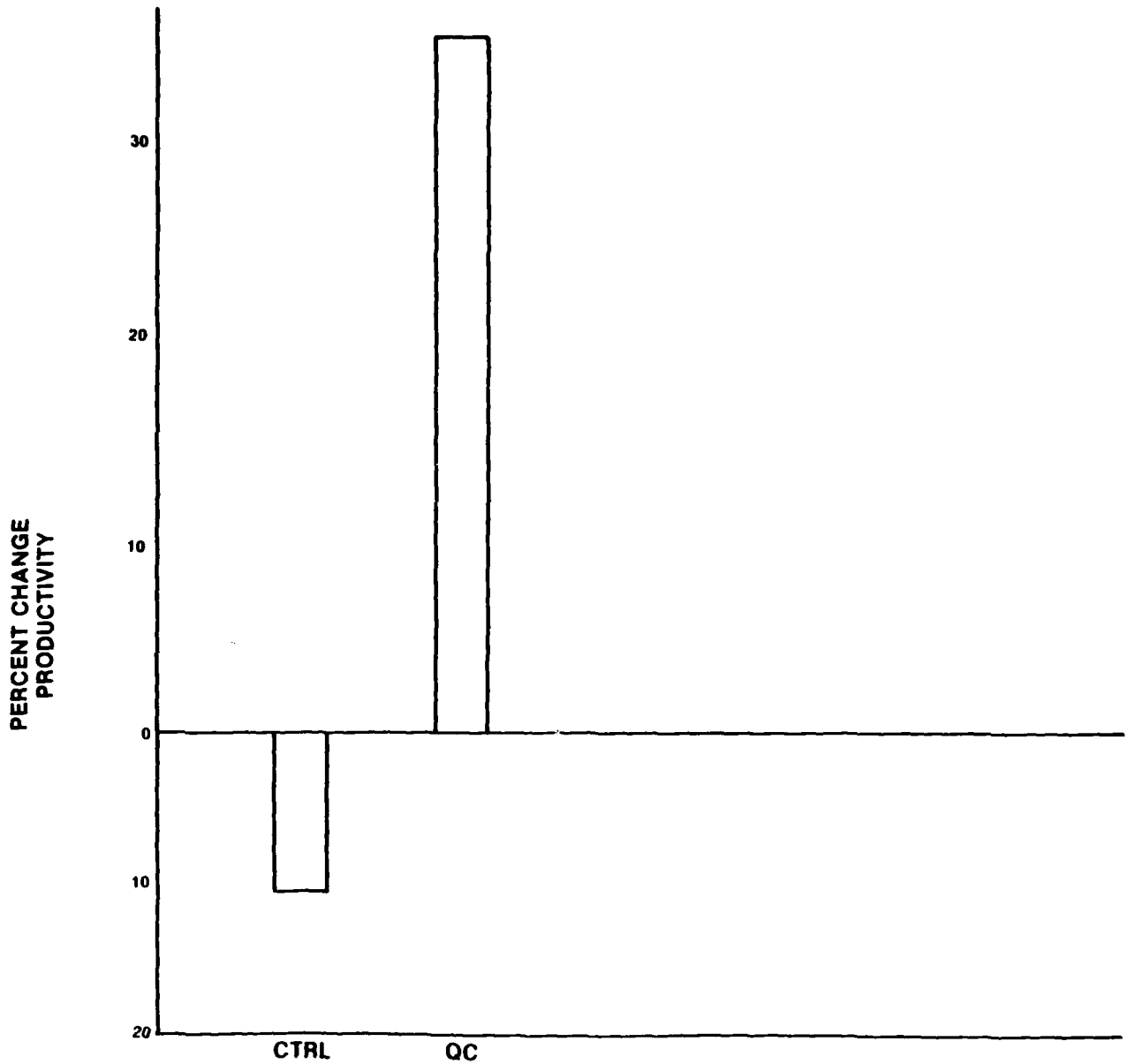


COMPANY C EFFICIENCY PAIR 4




PRODUCTIVITY AT COMPANY B PAIR 1
30
20
10
0
20
PRODUCTIVITY
26%
8%
27%
CTRL
QC
CTRL
QC
T1
T2

PRODUCTIVITY AT COMPANY B PAIR 2



APPENDIX C

JOB REACTION QUESTIONNAIRE

This appendix describes the Job Reaction Questionnaire and the scoring procedure. The results of the JRQ are described in the graphs and tables.

The Job Reaction Questionnaire was designed by Honeywell, Inc.'s Corporate Human Resources Research Department, Minneapolis, Minnesota. Completed in the Fall of 1980, the purpose of the questionnaire was to test workers' perceptions of their job environments. Honeywell's description of the questionnaire construction is included.

PRELIMINARY TECHNICAL NOTE

ON JOB REACTION QUESTIONNAIRE

9-24-80

The Job Reaction Questionnaire has been designed to ask about those aspects of work life which would probably be changed and improved as a result of production team participation.

Steps in Development

Those elements of the work situation that should change as a result of production team participation were rationally identified. We felt that two major processes go on in teams:

- Exchange of information which leads to changes in perception of:
  - Management Communication
  - Task Significance
  - Recognition and Feedback
  - Cooperation among work groups
- Identification and solution of problems leading to changes in perception of:
  - Use of Job Knowledge
  - Personal Influence
  - Efficiency

FIRST ITEM ANALYSIS

72 items on these dimensions were written and the questionaire was administered to about 100 workers in a factory setting.

Analysis

The results were statistically analyzed, leading to the following conclusions:

1. Some items were not successful in evoking critical, dissatisfied responses.

2. Most of the scales had excellent internal consistency and reliability, however four of the scales had unsatisfactory reliability.

3. Thirty-eight of the original seventy-two items were dropped as being nondiscriminating or not reliable.

4. New items were written in the following way:

   i) The reliable set of core items was examined to see what the meaning of that scale seemed to be so that other items could be written on the same subject.

   ii) The item writer attended several team meetings, interviewed team leaders and team members, and from these sources wrote items on the previously identified dimensions that reflected what participants did and said.

   iii) An experienced team observer also contributed items.

Fifty-eight new items were written, which together with the thirty-four items from the old form, made up the new item pool of 92 items.

SECOND ITEM ANALYSIS

The second set of 92 items was administered to 100 hourly workers (primarily factory workers) from 2 companies. Items were selected on the basis of:

1. Loadings on factors - used factor analysis to explore relations among items.

2. Internal reliability of each scale.

3. Minimizing the intercorrelations of the scales.

In this second development sample, reliability of the final set was as follows (there are six items on each scale):

Reliability Table

Item	Cronbach's Alpha
Work Planning and Efficiency	.82
Cooperation Among Work Groups	.77
Management Communication	.79
Personal Influence	.83
Use of Job Knowledge	.85
Task Significance	.82
Recognition/Interpersonal Feedback	.80

Of course, since items were chosen to maximize internal reliability, these estimates may be somewhat inflated.

The scale intercorrelations on the same development sample follows:

	WORK PLANNING/ EFFICIENCY	COOPERATION	MANAGEMENT COMMUNICATION	PERSONAL INFLUENCE	JOB KNOWLEDGE	TASK SIGNIFICANCE	RECOGNITION
WORK PLANNING/ EFFICIENCY	-						
COOPERATION	.49	-					
MANAGEMENT COMMUNICATION	.63	.53	-				
PERSONAL INFLUENCE	.57	.50	.57	-			
JOB KNOWLEDGE	.24	.51	.42	.49	-		
TASK SIGNIFICANCE	.42	.52	.43	.51	.62	-	
RECOGNITION	.37	.54	.42	.61	.64	.52	-

VALIDITY

There is a content validity argument to be made for this instrument, since items were straightforwardly written to reflect particular domains.

There is also the beginning of construct validity evidence since, for the most part, the items define separate factors.

In the future we hope to investigate:

1) Whether the instrument will work as a change measure in assessing the impact of an intervening activity such as Quality Circles.

2) Whether the instrument correlates in expected ways with other job climate measures.

JOB REACTION QUESTIONNAIRE—DESCRIPTION OF THE SCALES

Scale 1--Work Planning and Efficiency

Lack of delays, confusion, waste. Planning for and quick solution of problems.

Scale 2--Cooperation Among Work Groups

Smooth running organization, cooperation from other areas, sections or functions.

Scale 3--Management Communication

Management perceived as listening to employee problems and opinions, acting on employee suggestions.

Scale 4--Personal Influence

Emphasis on the pronoun "I". I personally feel that I have impact, can bring about change, influence decision-making.

Scale 5--Use of Job Knowledge

Talents, skills, experience are being used on the job. Employee is learning, being trained.

Scale 6--Task Significance

Understanding of how one's work relates to a larger context: goals of workgroup, people on other jobs, the eventual destination and use of parts, products or services.

Scale 7--Recognition/Interpersonal Feedback

Quantity, speed and helpfulness of feedback about work performance.

Recognition of positive contributions by supervisor or coworkers.

HONEYWELL JOB REACTION QUESTIONNAIRE SCORING

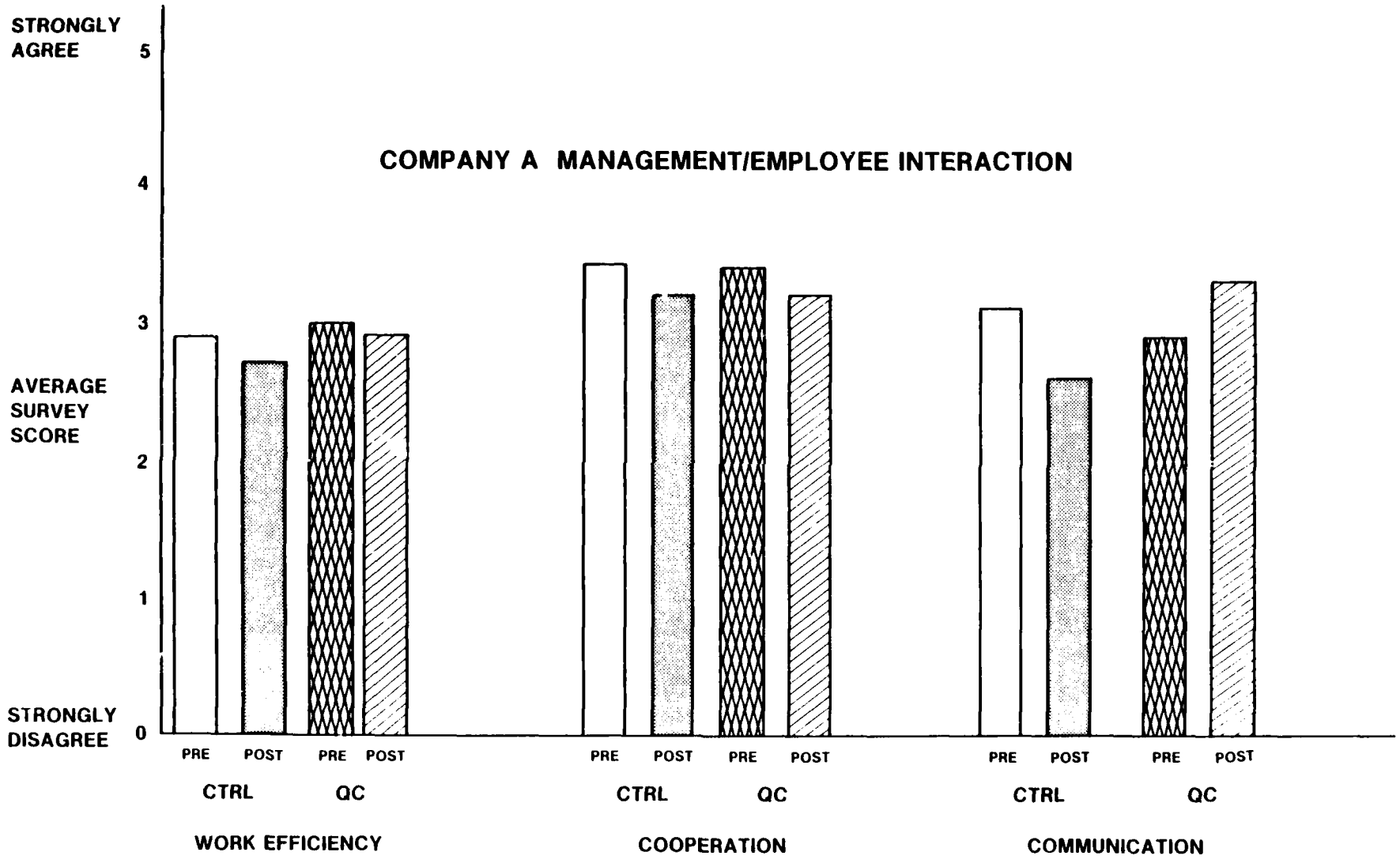
Blanks weretreated as missing data. They werenot included in the scale mean calculations.

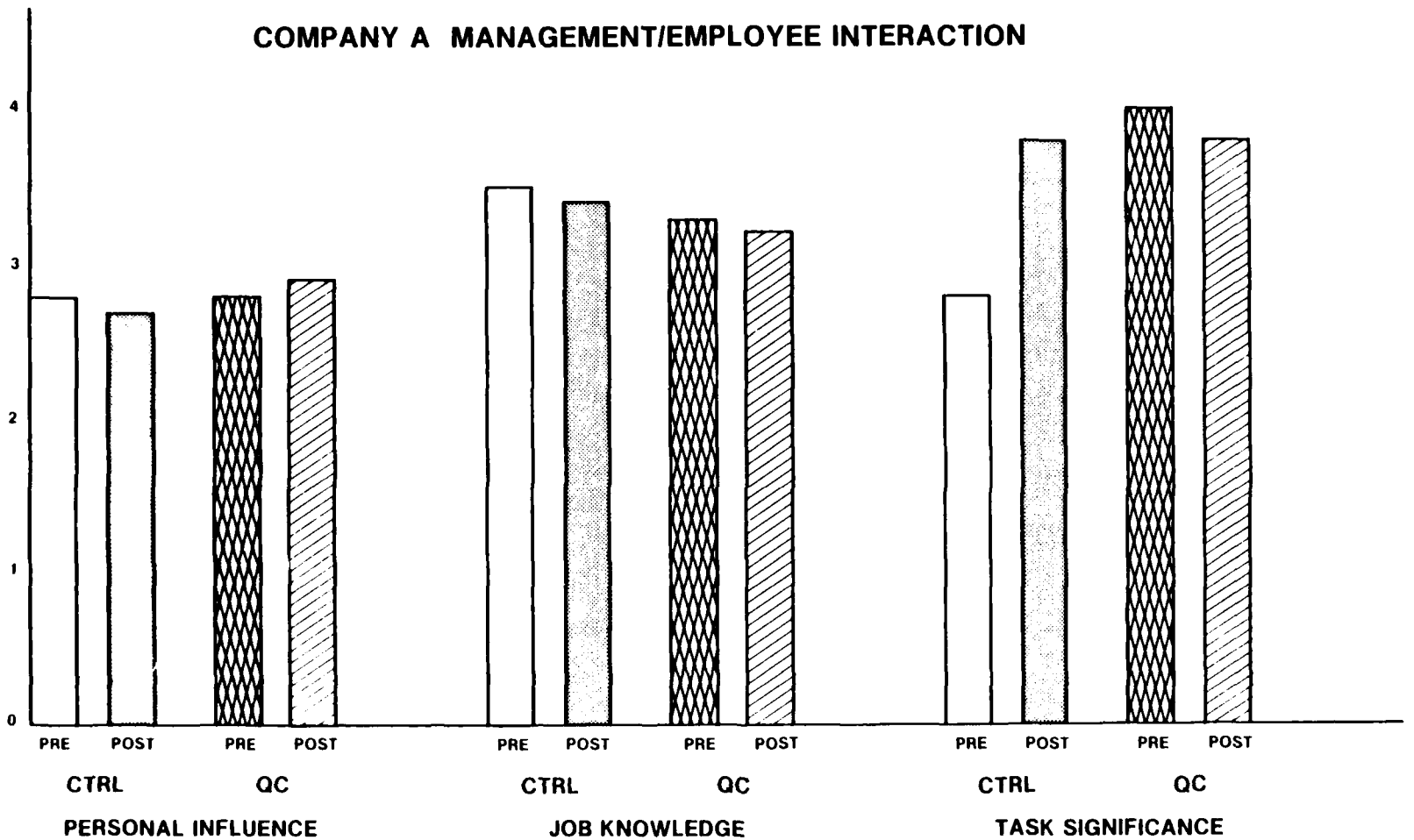
$$\text{mean for scale i} = \frac{\text{sum of the items in scale i = blank}}{\text{\# items in scale i = blank}}$$

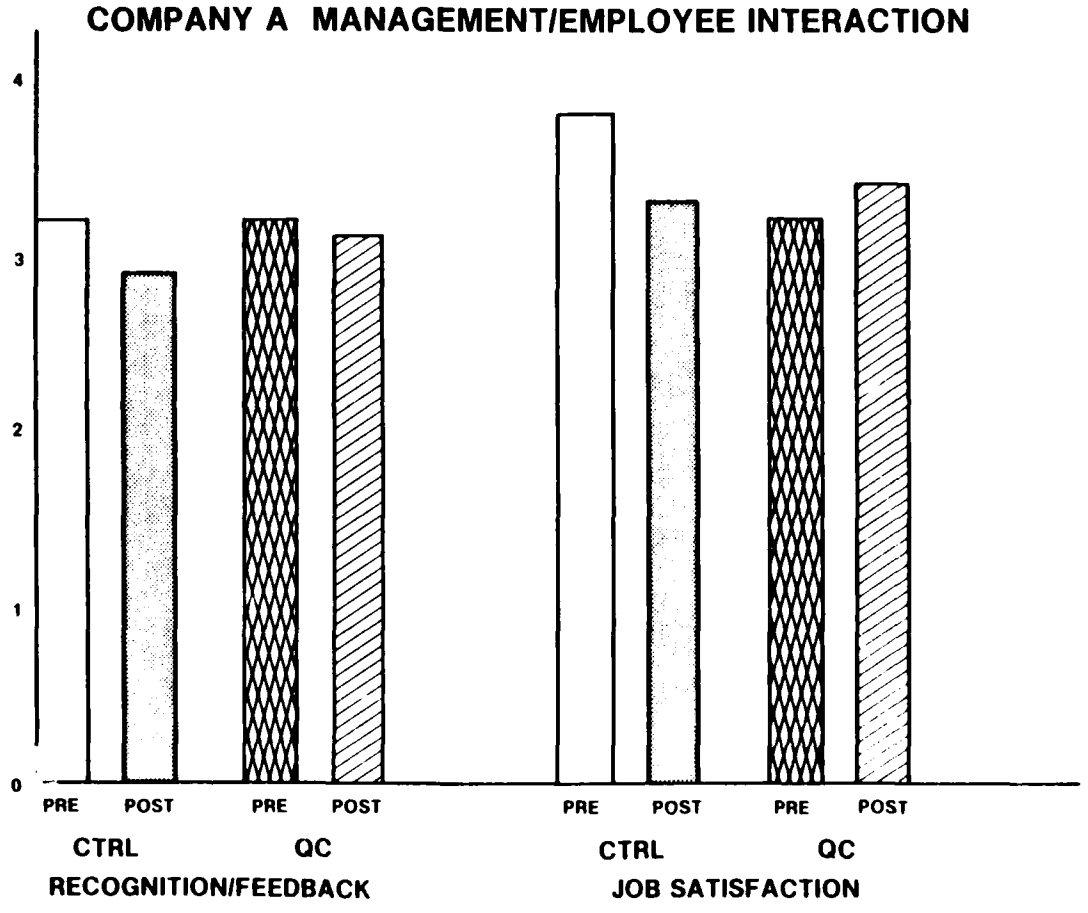
The questions in each scale are:

scale	Questions							
1	1	2	8	9	15	22	29	36
2	16	23	30	37				
3	3	10	17	24	31	38		
4	4	11	18	25	32	39		
5	5	12	19	26	33	40		
6	6	13	20	27	34	41		
7	7	14	21	28	35	42		
8	43							

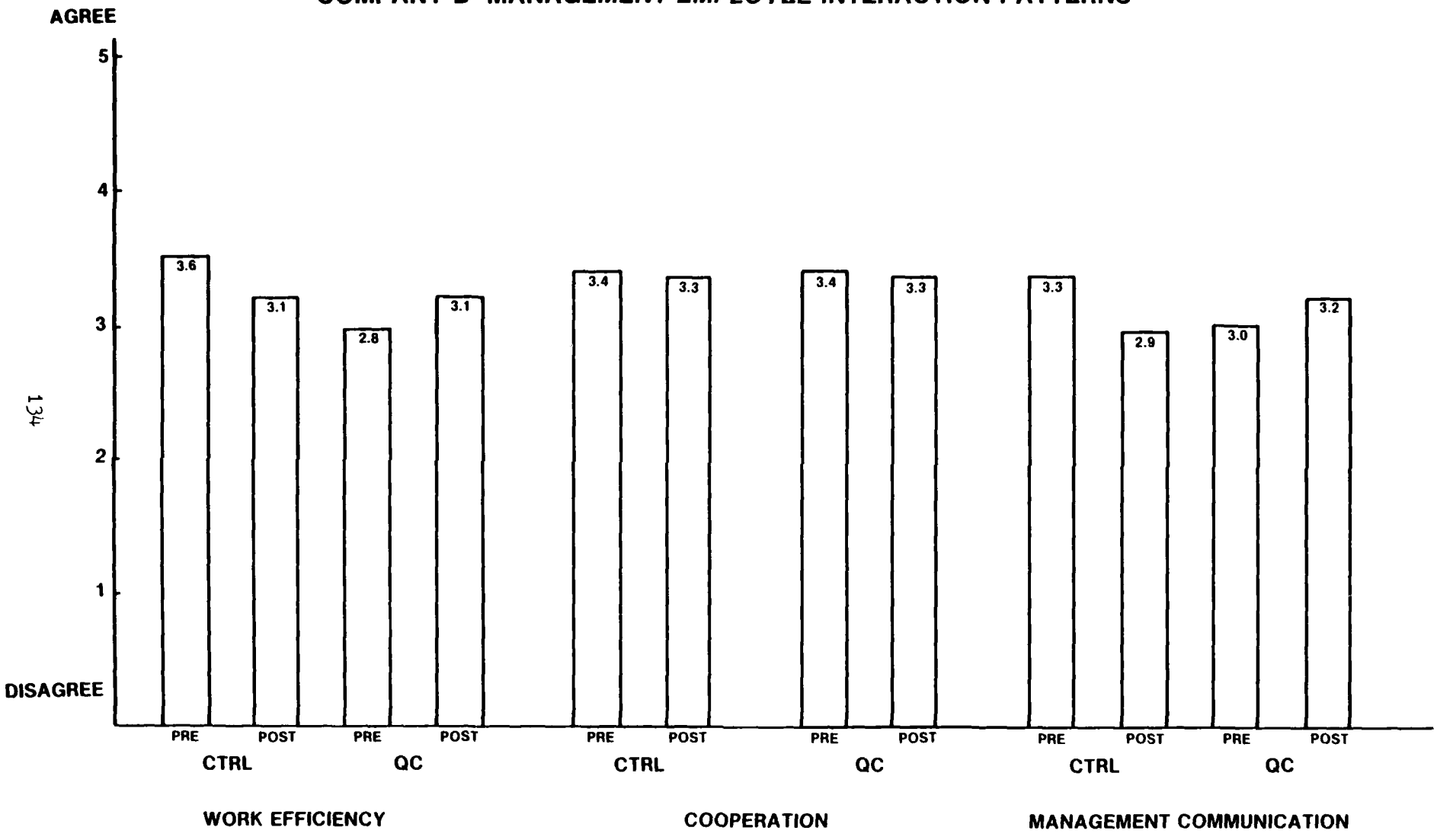
The pre-test was machine scored by Honeywell while the post-test was hand scored by Business Innovations. One score on each scale was obtained for each group by weighting each person and each question equally.


COMPANY A MANAGEMENT/EMPLOYEE INTERACTION
STRONGLY AGREE
5
4
3
AVERAGE SURVEY SCORE
2
1
STRONGLY DISAGREE
0
PRE
POST
PRE
POST
CTRL
QC
WORK EFFICIENCY
COOPERATION
COMMUNICATION

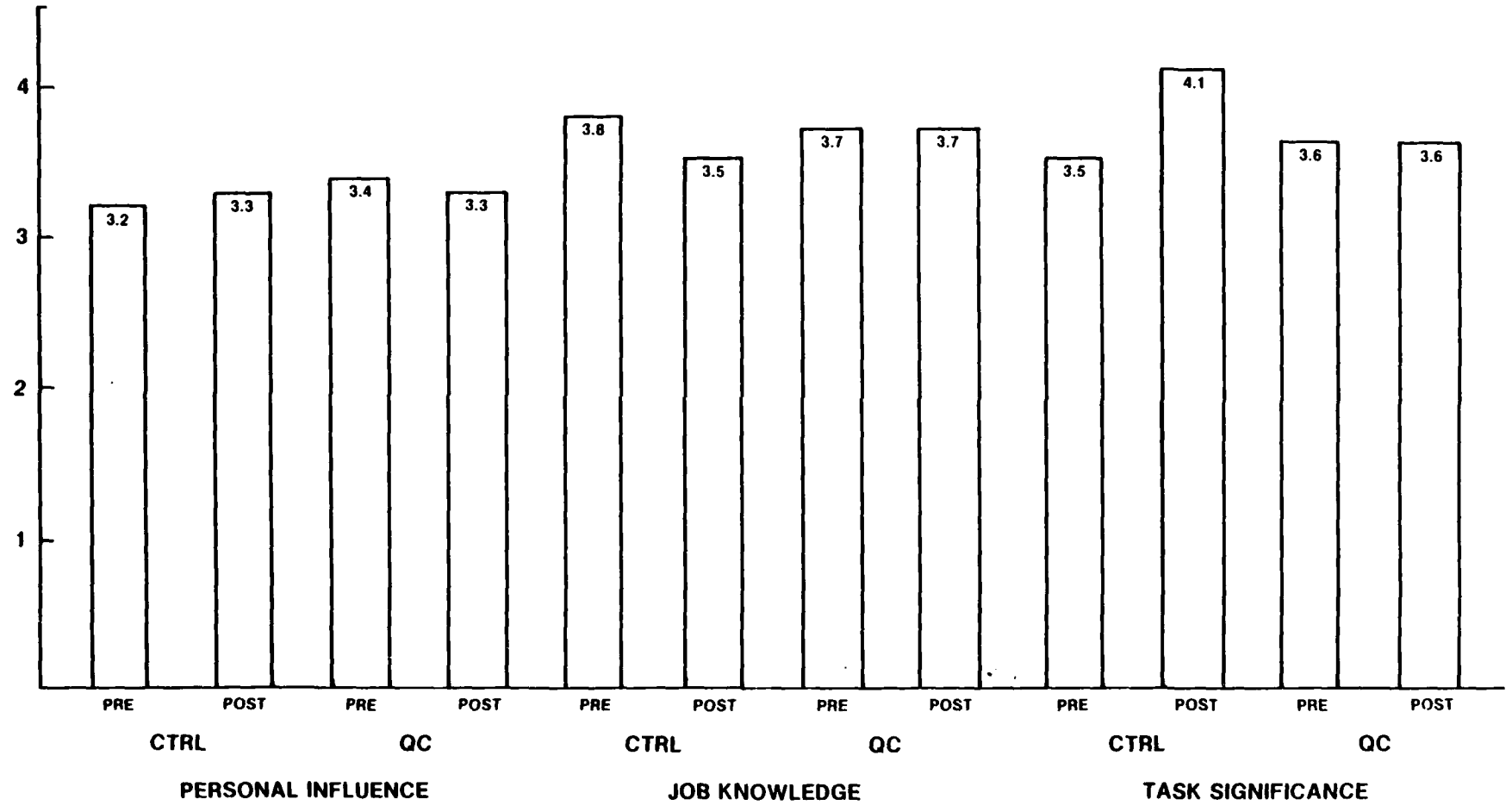

COMPANY A MANAGEMENT/EMPLOYEE INTERACTION
4
3
2
1
0
PRE
POST
PRE
POST
CTRL
QC
PERSONAL INFLUENCE
PRE
POST
PRE
POST
CTRL
QC
JOB KNOWLEDGE
PRE
POST
PRE
POST
CTRL
QC
TASK SIGNIFICANCE


COMPANY A MANAGEMENT/EMPLOYEE INTERACTION
4
3
2
1
0
PRE
POST
PRE
POST
PRE
POST
PRE
POST
CTRL
QC
CTRL
QC
RECOGNITION/FEEDBACK
JOB SATISFACTION

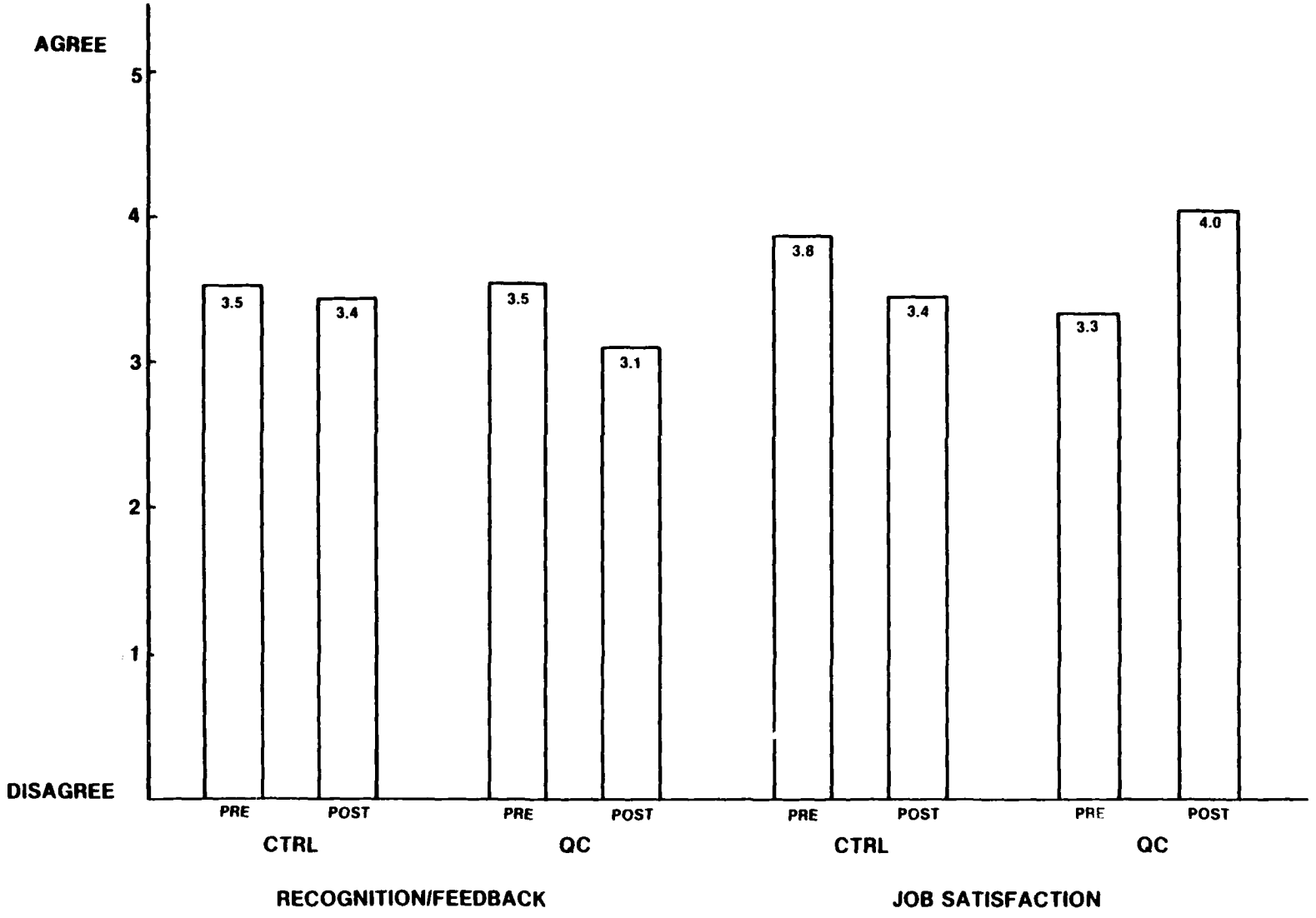
COMPANY B MANAGEMENT EMPLOYEE INTERACTION PATTERNS

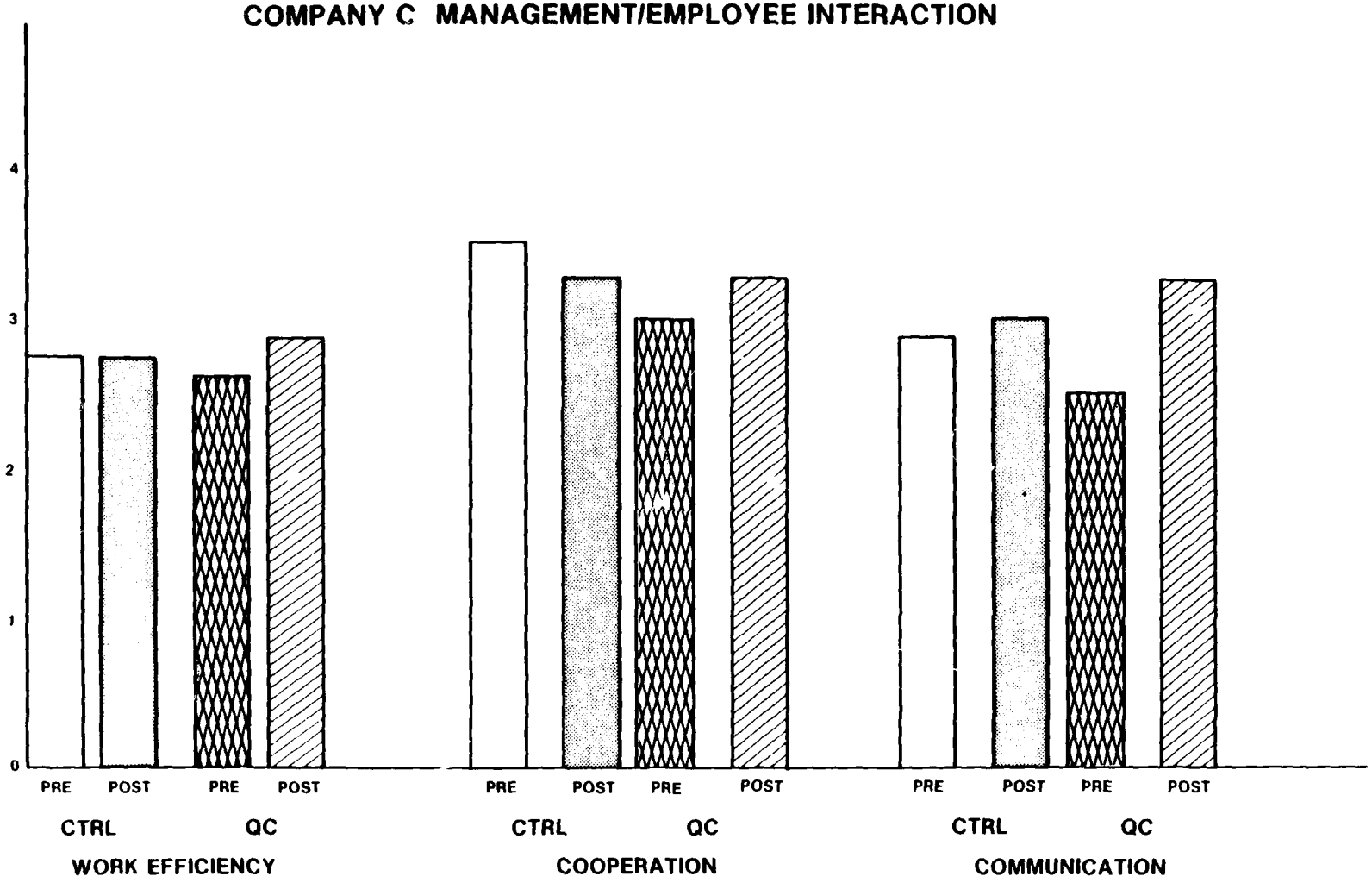


COMPANY B MANAGEMENT EMPLOYEE INTERACTION PATTERNS II

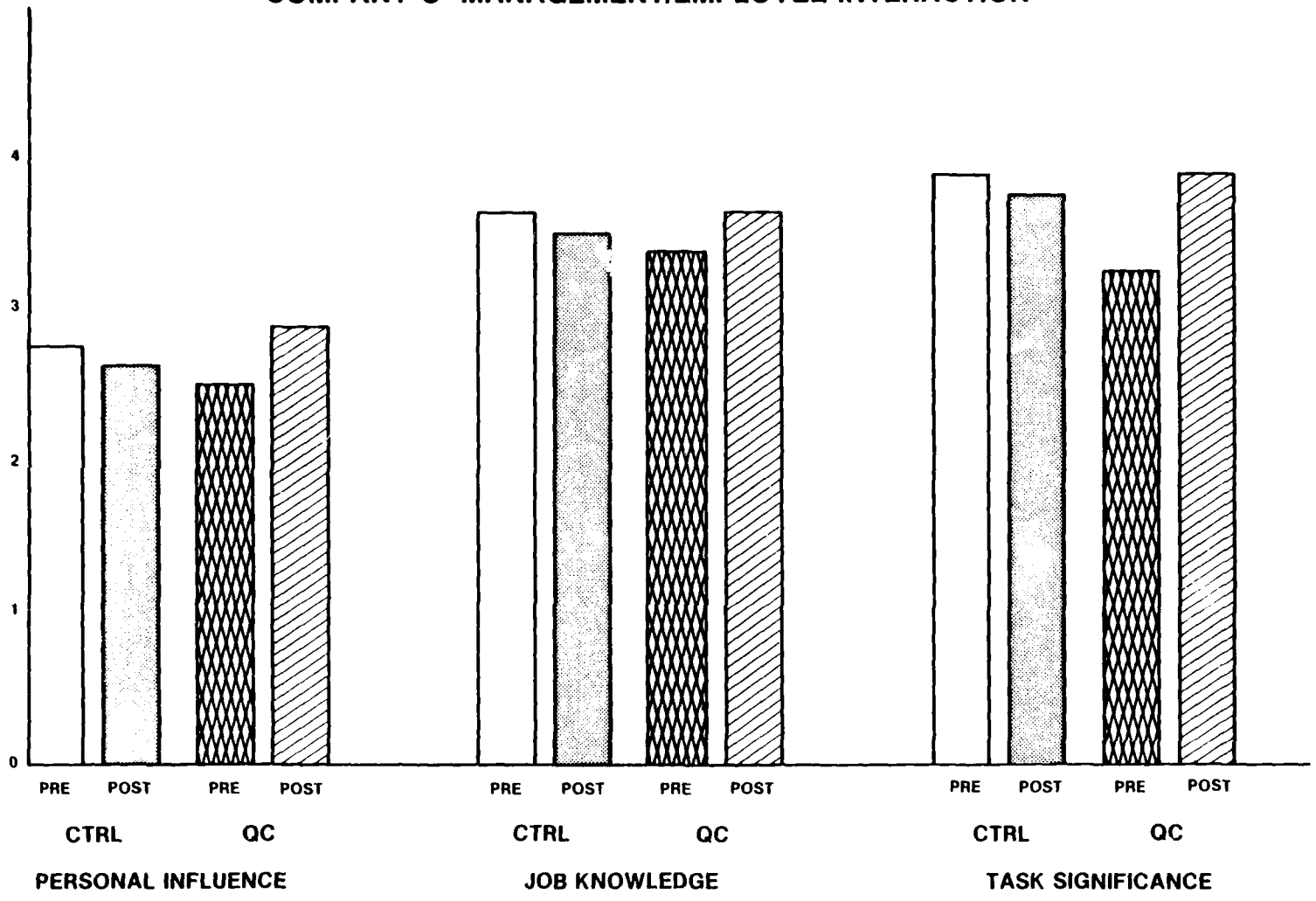


COMPANY B MANAGEMENT EMPLOYEE INTERACTION PATTERNS III

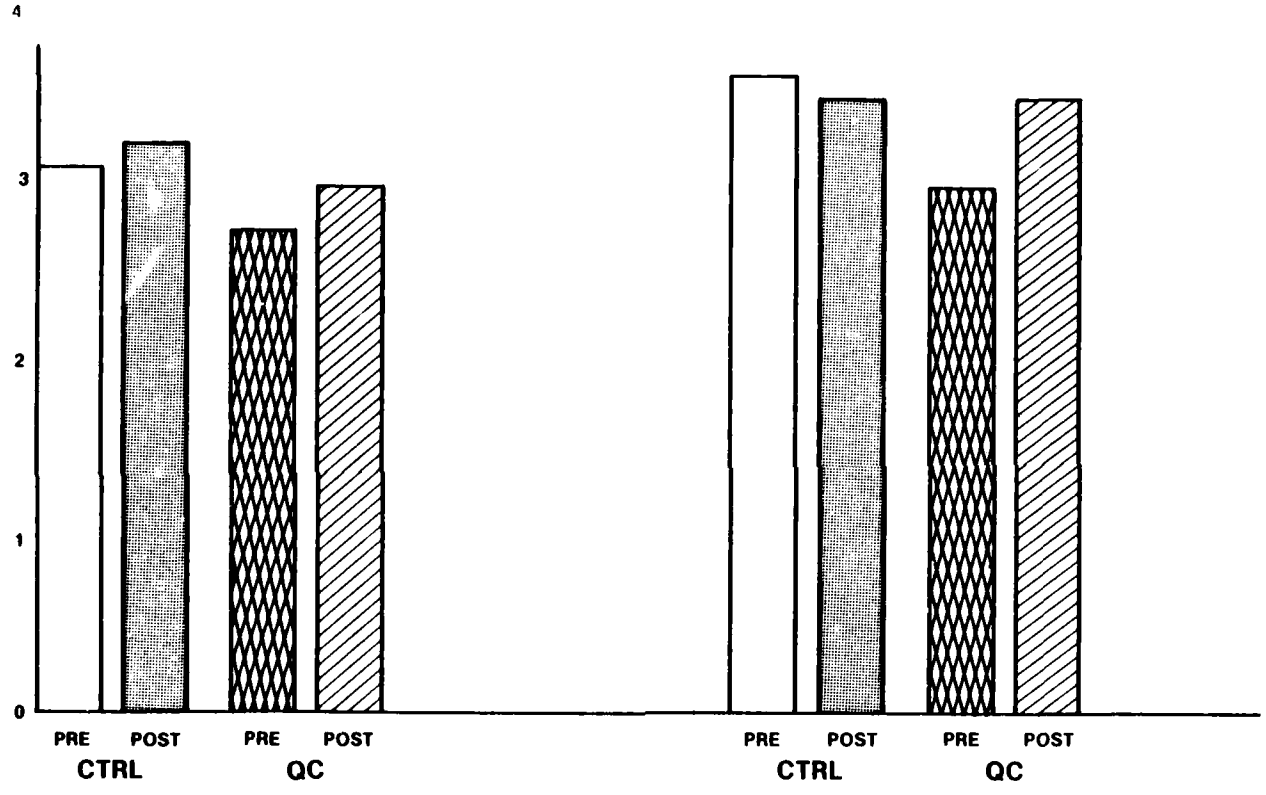



COMPANY C MANAGEMENT/EMPLOYEE INTERACTION
4
3
2
1
0
PRE
POST
PRE
POST
CTRL
QC
WORK EFFICIENCY
PRE
POST
PRE
POST
CTRL
QC
COOPERATION
PRE
POST
PRE
POST
CTRL
QC
COMMUNICATION

COMPANY C MANAGEMENT/EMPLOYEE INTERACTION



COMPANY C MANAGEMENT/EMPLOYEE INTERACTION



WORK EFFICIENCY SCALE PRETEST BY COMPANY AND BY QC/CONTROL

Company	A	B	C
x	2.9	3.6	2.7
sd	0.4	.9	0.5
n	4	3	4
Q.C.			
x	3.0	2.8	2.6
sd	0.2	.8	0.7
n	5	4	4

x = Mean

sd = Standard Deviation

n = Sample Size

WORK EFFICIENCY POST-TEST BY COMPANY AND BY QC/CONTROL

Company	A	B	C
Control			
x	2.7	3.1	2.8
sd	0.2	.2	0.3
n	4	2	4
Q.C.			
x	2.9	3.1	2.9
sd	0.2	.4	0.6
n	5	4	4

COOPERATION SCALE PRETEST BY COMPANY AND BY QC/CONTROL

Company	A	B	C
Control			
x	3.4	3.4	3.2
sd	0.2	1.0	0.4
n	4	3	4
Q.C.			
x	3.4	3.4	3.0
sd	0.3	.8	0.5
n	5	4	4

COOPERATION SCALE POST-TEST BY COMPANY BY QC/CONTROL

Company	A	B	C
Control			
x	3.1	3.3	3.2
sd	0.4	.2	.3
n	4	2	4
Q.C.			
x	3.1	3.3	3.2
sd	0.3	.4	.3
n	5	3	4

MANAGEMENT COMMUNICATION SCALE PRE-TEST

TEST BY COMOPANY AND BY QC/CONTROL

Company	A	B	C
Control			
x	3.1	3.3	2.9
sd	0.2	1.0	0.4
n	4	3	4
Q.C.			
x	2.9	3.0	2.5
sd	0.4	.9	0.6
n	5	4	4

MANAGEMENT COMMUNICATION SCALE POST-TEST

BY COMPANY AND BY QC/CONTROL

Company	A	B	C
Control			
x	2.6	2.9	3.0
sd	0.3	.2	.2
n	4	2	4
Q.C.			
x	3.3	3.2	3.2
sd	0.3	.2	.6
n	5	3	4

PERSONAL INFLUENCE SCALE PRE-TEST BY COMPANY AND BY QC/CONTROL

Company	A	B	C
Control			
x	2.8	3.2	2.8
sd	0.1	1.0	0.5
n	4	3	4
Q.C.			
x	2.8	3.4	2.5
sd	0.5	.9	0.6
n	5	4	4

PERSONAL INFLUENCE SCALE POST-TEST BY COMPANY AND BY QC/CONTROL

Company	A	B	C
Control			
x	2.7	3.3	2.7
sd	0.6	.1	.4
n	4	2	4
Q.C.			
x	2.9	3.3	2.9
sd	0.2	.4	0.4
n	5	4	4

JOB KNOWLEDGE SCALE PRE-TEST BY COMPANY AND BY QC/CONTROL

Company	A	B	C
Control			
x	3.5	3.8	3.7
sd	0.3	1.0	0.6
n	4	3	4
Q.C.			
x	3.3	3.7	3.3
sd	0.3	.9	0.6
n	5	4	4

JOB KNOWLEDGE SCALE POST-TEST BY COMPANY AND QC/CONTROL

Company	A	B	B
Control			
x	3.4	3.5	3.5
sd	.4	.1	.3
n	4	2	4
Q.C.			
x	3.2	3.7	3.5
sd	.4	.1	.2
n	5	3	4

TASK SIGNIFICANCE SCALE PRE-TEST BY COMPANY AND BY QC/CONTROL

Company	A	B	C
Control			
x	2.8	3.5	3.9
sd	0.5	1.0	0.4
n	4	3	4
Q.C.			
x	4.0	3.6	3.2
sd	0.3	.8	0.8
n	5	4	4

TASK SIGNIFICANCE SCALE POST-TEST

BY COMPANY AND BY QC/CONTROL

Company	A	B	C
Control			
x	3.8	4.1	3.7
sd	.3	.2	.5
n	4	2	4
Q.C.			
x	3.8	3.6	3.9
sd	.3	.4	.3
n	5	3	4

RECOGNITION/FEEDBACK SCALE PRE-TEST

BY COMPANY AND BY QC/CONTROL

Company	A	B	C
Control			
x	3.2	3.5	3.1
sd	0.3	1.1	0.5
n	4	3	4
Q.C.			
x	3.2	3.5	2.8
sd	0.6	1.0	0.7
n	5	4	4

RECOGNITION/FEEDBACK SCALE POST-TEST

BY COMPANY AND BY QC/CONTROL

Company	A	B	C
Control			
x	2.9	3.4	3.2
sd	.5	.3	.3
n	4	2	4
Q.C.			
x	3.1	3.1	3.0
sd	.4	.6	.5
n	5	3	4

JOB SATISFACTION SCALE PRE-TEST

BY COMPANY AND BY Q.C. CONTROL

Company	A	B	C
Control			
x	3.8	3.8	3.7
sd	0.3	1.5	0.6
n	4	3	4
Q.C.			
x	3.2	3.3	3.0
sd	0.6	1.6	1.9
n	5	4	4

JOB SATISFACTION SCALE POST-TEST

BY COMPANY AND BY QC/CONTROL

Company	A	B	C
Control			
x	3.3	3.4	3.6
sd	.3	.3	.8
n	4	2	4
Q.C.			
x	3.4	4.0	3.4
sd	.4	.2	.2
n	5	3	4

APPENDIX D

DESCRIPTIVE MEDIATING VARIABLES

The tables in this appendix are the descriptive data on the second subset mediating variables. They are broken down by company and by experimental and control groups. The distinctions between companies are identical with the distinctions between white collar and blue collar work groups. Company A is white collar, and Companies B and C are blue collar. There were no union groups in these tables. The tables appear in the following order:

D1 Mean Age
D2 Percent Male
D3 Mean Years of Education
D4 Mean Years Performing Same Job
D5 Mean Years Employed by Company
D6 Mean Number of Different Jobs at Company
D7 Number of Employees in Each Work Group
D8 Number of Persons Subunit Manager Supervises
D9 Number of Different Job Titles
D10 Number of Hours/Week Work Groups Spend in Meetings
D11 Type of Technology, Custom
D12 Type of Technology, Small Batch
D13 Type of Technology, Large Batch
D14 Type of Technology, Mass Production
D15 Type of Technology, Continuous Process

TABLE D1

MEAN AGE BY COMPANY AND BY QC/CONTROL

Company	A	B	C
Control			
x	38.3	27.0	49.0
sd	9.9	2.1	8.0
n	4	4	4
Q.C.			
x	38.0	26.3	49.9
sd	5.1	1.8	5.2
n	5	4	4

The mean age at Company C is significantly higher than at Company A (about 11 years). Differences between control and experimental groups at both companies are negligible. Company B employees are the youngest.

TABLE D2

PERCENT MALE BY COMPANY AND BY QC/CONTOL

Company	A	B	C
Control			
x	32.0	90.0	19.3
sd	27.9	17.3	38.5
n	4	4	4
Q.C.			
x	48.6	93.8	18.8
sd	27.9	10.8	17.0
n	5	4	4

The groups at Company C are predominantly female. Company A has a higher percentage of males in its groups, especially in the QC groups. This difference at Company A between the experimental and control groups may prove to be significant. Company B experimental and control groups are similar and predominantly male.

TABLE D3

MEAN YEARS OF EDUCATION

BY COMPANY AND BY QC/CONTROL

Company	A	B	C
Control			
x	13.7	9.8	10.9
sd	2.0	2.0	0.9
n	4	4	4
Q.C.			
x	14.0	9.8	10.4
sd	1.3	2.0	0.9
n	5	4	4

The mean number of years of education is significantly higher for Company A than for Companies B and C. Employees at Companies B and C have had some high school, while a couple of years of college is the norm at Company A. This is not surprising, since the companies vary in terms of white collar vs. blue collar jobs. Differences between control and QC groups at all three companies are negligible.

TABLE 54

MEAN YEARS PERFORMING SAME JOB

BY COMPANY AND BY QC/CONTROL

Company	A	B	C
Control			
x	6.6	1.7	11.3
sd	3.0	.8	4.9
n	4	4	4
Q.C.			
x	7.5	2.7	11.3
sd	6.4	.9	6.5
n	5	4	4

The mean length of time performing the same job is substantially higher at Company C than at Company A. Differences between experimental and control groups are negligible. Company B employees have considerable less job experience.

TABLE D5

MEAN YEARS EMPLOYED BY COMPANY

BY COMPANY AND BY QC/CONTROL

Company	A	B	C
Control			
x	11.7	1.8	18.7
sd	7.8	.8	4.9
n	4	4	4
Q.C.			
x	13.0	2.6	17.4
sd	5.4	.92	3.6
n	5	4	4

The mean length of employment at Company C is substantially longer than at Company A. Differences between the control and experimental groups at both companies are negligible. There was more variation of length of employment at Company A. Company B has a very low lenth of employment compared to A or C.

TABLE D6

MEAN NUMBER OF DIFFERENT JOBS AT COMPANY

BY COMPANY AND BY QC/CONTROL

Company	A	B	C
Control			
x	1.9	1.2	4.7
sd	0.8	.2	2.2
n	4	4	3
Q.C.			
x	2.1	1.1	3.0
sd	0.8	.2	0.5
n	5	4	4

The mean number of different jobs was slightly higher at Company C than Company A, and was lower at Company B. Differences bet experimental groups are negligible.

TABLE D7

NUMBER OF EMPLOYEES IN EACH WORK GROUP

BY COMPANY AND BY QC/CONTROL

Company	A	B	C
Control			
x	9.0	20.0	7.0
sd	2.6	19.8	2.6
n	4	3	4
Q.C.			
x	9.4	11.7	8.8
sd	2.1	8.2	1.3
n	5	3	4

No differences are found between companies or by QC/Control.

TABLE D8

NUMBER OF PERSONS SUBUNIT MANAGER SUPERVISES

Company	A	B	C
Control			
x	5.3	20	10.3
sd	1.5	9.8	8.5
n	3	3	3
Q.C.			
x	8.4	11.7	16.0
sd	6.4	8.2	5.4
n	5	3	4

Managers at Company C supervise significantly more people than those at Company A. QC managers at both companies manage more people than control groups.

TABLE D9

NUMBER OF DIFFERENT JOB TITLES IN THE WORK GROUP

Company	A	B	C
Control			
x	2.5	3.0	1.8
sd	1.3	1.4	1.5
n	4	3	4
Q.C.			
x	3.2	3.0	2.3
sd	1.1	1.4	2.5
n	5	3	4

TABLE 10

NUMBER OF HOURS/WEEK GROUPS SPEND IN MEETINGS

Company	A	B	C
x	5.8	0.0	0.0
sd	6.8	0.0	0.0
n	4	4	4
Q.C.			
x	1.3	0.0	0.0
sd	17.9	0.0	0.0
n	3	4	4

Company A groups spend more hours in meetings than Company C or B, especially the control groups.

TABLE D11

TYPE OF TECHNOLOGY

CUSTOM

Company	A	B	C
Control			
x	--	3.3	1.0
sd	--	1.9	0
n	--	3	4
Q.C.			
x	4.2	3.3	1.0
sd	3.0	1.9	0
n	5	3	4

TABLE D12

TYPE OF TECHNOLOGY

SMALL BATCH

Company	A	B	C
Control			
x	--	1.7	2.5
sd	--	.5	3.0
n	--	3	4
Q.C.			
x	4.0	1.7	2.5
sd	2.7	.5	3.0
n	5	3	4

TABLE D13

TYPE OF TECHNOLOGY

LARGE BATCH

Company	A	B	C
Control			
x	--	1	5.5
sd	--	0	3.0
n	--	3	4
Q.C.			
x	5.8	1	5.5
sd	2.7	0	3.0
n	5	3	4

TABLE D14

TYPE OF TECHNOLOGY

MASS PRODUCTION

Company	A	B	C
Control			
x	--	1.0	2.5
sd	--	0.0	3.0
n	--	3	4
Q.C.			
x	5.8	1.0	2.5
sd	2.7	0.0	3.0
n	5	3	4

TABLE D15

TYPE OF TECHNOLOGY

CONTINUOUS PROCESS

Company	A	B	C
Control			
x	--	1.0	1.0
sd	--	0.0	0.0
n	--	3	4
Q.C.			
x	3.8	1.0	1.0
sd	3.0	0.0	0.0
n	5	3	4

APPENDIX E

General Interview/Observational Data

General Interview/Observational Data

In addition to the data relating to specific variables, the following results of general interest were obtained.

1. All the quality circles except two were operating at T_3, 12 to 15 weeks after training. Participation and enthusiasm were high, and goal oriented activity dominated the meetings. All the circles had set objectives and were working on solving problems they had identified. Primarily, meeting time was used to present data, brainstorm, prioritize, make assignments and/or give management presentations. Both management and group members felt the quality circles were effective and useful.

2. At the time of post-test interviews, all parties felt it was too early to fully evaluate the program. Only two circles had implemented a major work change project resulting from quality circle activity. Ten others had received approval for changes but had not yet implemented them, and six quality circles had given management presentations. The presentations were given to the managers up to three levels above the group leader in the normal chain of command. All of the recommendations except one were accepted by management. Management generally concluded that the circles had made excellent presentations. One presentation was considered so exceptional that management asked the circle to present it again for video taping.

3. Many of the circles had overcome one or more major difficulties or crises which had threatened the existence of the circle at some point during the study. These events mostly dealt with issues of internal group dynamics and initial skepticism by one or more circle members. Several circle leaders felt that more training, especially in group dynamics, would be desirable. Almost all the trainees, however, evaluated the training very positively.

4. All the quality circles except two felt they received support from their immediate management. This support was thought by the circle members to be critical to the success of the circles. The one circle which complained of lack of such support decreased in productivity. Support for the quality circles from management varied from manager to manager. Some were actively supportive, others were passively supportive or non-supportive, and a small minority were actively non-supportive.

5. Group members felt that communication within the circles and with management had improved substantially. Those circles which had interfaced with other departments felt they had greatly improved communication with those departments as well. In an internal report to management, one circle leader had this to say:

> "The quality circle program is already influencing the workings of the Customer Service/Planning department. The staff is much more aware of other members' duties. They are more conscious of how their work fits into the overall department product. The department members are also more aware that they as individuals are not fault-proof, and are working

to improve personal work quality."

6. Most quality circles members felt that self development and increased self esteem were major benefits of the program. A notable example involved two quality circles which had implemented a solution that required each member of the circle to consult with managers in other departments. None of the circle members had spoken to any managers at that level before. The solution produced dramatic improvements within a few weeks. This example also underscores the principle that implementation of solutions by the quality circle members increases the members self development, self esteem and their commitment to making the solutions work.

7. The quality circles relationship to quality control departments was not clear. Company A had two circles in the quality assurance department which had more difficulties with motivation of the circle members than the other circles. The difficulties appeared to be related to a feeling by the members that they were already experts in quality control and did not need further training or application of quality control techniques in their own department. Also, these people work more as individual consultants to other departments than as a work group with a common identifiable output. A possible solution to this problem is to allow the quality control department personnel become members of quality circles in the departments they monitor. This would, however, have to be done in such a way that the group members were not

intimidated or dominated by the quality control person. This solution is planned at Company C after the circles have achieved more self-confidence and stabiliity. However, a circle within the quality control department at Company B is also planned.

8. A number of blue collar circles at Companies B and C were very dependent on the facilitator at the time of the post-test interviews. In several cases the facilitator assisted the group leader by recording the suggestions on newsprint, while the circle leaders focused on running the meeting. In some cases the facilitators directed part of the meetings. The facilitators were conscious of the need to shift this dependence away from themselves back to the group members, and they were doing so gradually. This observation underscores the importance of the capabilities of the facilitator in maximizing the effectiveness of quality circles.

9. The steering committees did not play a major role in the programs after the initial start up planning. None of the committees had met more than twice during the study. This was partly because there was not any critical action for them to take at the time. The major responsibilities now facing the steering committees are giving recognition to the quality circles achievements and planning the expansion of the program. However, this observation supports the literature which claims that steering committees are not effective at giving quality

circles operational or motivational support on an on-going, day to day basis. Other vehicles than the steering committee must be utilized to give circles this needed support.

10. The people involved in the quality circles program voiced strong positive personal feelings about the program. One circle member asked for and received permission to continue attending quality circle meetings even after her temporary position at the company was terminated. Other evidence of positive feelings were the praise which upper management lavished on quality circles members. At one meeting three high level managers of quality control, production, and the department head of the quality circle leader were so impressed with the data the circle had gathered that they told the members several times that it was exactly the kind of data that was needed. "You are to be commended. I'm proud of you. You've done a fine job," was heard repeatedly. One circle leader stated that the quality circle training was more valuable to him than his entire college education.

11. Periodically, the circle leaders who had been trained together held meetings to exchange ideas, discuss problems and give each other mutual support. The leaders generally felt these meetings were very valuable and needed to be increased and expanded to include meetings with quality circle leaders in other companies.

12. Examples of quality circle achievements were:

Item	Benefit or Projected Savings
(1) Departmental policy change allowing fewer requirements for multiple reporting and approval of purchase orders.	55,000 manhours/yr.
(2) Consultation with foremen by timekeepers to reduce inaccurate and late time cards.	11,000 manhours/yr.
(3) Change in computer program to allow scheduling department greater control over shop tickets.	No estimate.
(4) Addition of portable building to house and organize drafting records.	No estimate.
(5) Development of presentation on defect prevention.	Added to training program.
(6) Simultaneous credit check and order placement for repeat customers.	Reduced turnaround time on order scheduling by 50%.
(7) Established productivity measures for department. Cleaned up area. Organized tools. Eliminated a step in production by designing reusable chamfer.	Saved time hunting for for tools. Improved mobility in area. Do not have to replace chamfer daily.
(8) Standardization of forms to reduce data errors. Elimination of duplicate reporting.	Increased transactions/manhour 60%. Reduction of errors.
(9) Reduction of reruns.	$60,000/yr.

LIST 1
MANDATORY

Defense Technical Information Center (12 copies)
ATTN: DTIC DDA-2
Selection and Preliminary Cataloging Section
Cameron Station
Alexandria, VA 22314

Library of Congress
Science and Technology Division
Washington, D.C. 20540

Office of Naval Research (3 copies)
Code 4420E
800 N. Quincy Street
Arlington, VA 22217

Naval Research Laboratory (6 copies)
Code 2627
Washington, D.C. 20375

Office of Naval Research
Director, Technology Programs
Code 200
800 N. Quincy Street
Arlington, VA 22217

LIST 2
ONR FIELD

Psychologist
Office of Naval Research
Detachment, Pasadena
1030 East Green Street
Pasadena, CA 91106

Dr. James Lester
Office of Naval Research
Detachment, Boston
495 Summer Street
Boston, MA 02210

P4-5/A5
Sequential by OPNAV Code

452:ND:716:enj
78u452-883

LIST 3
OPNAV

Deputy Chief of Naval Operations
(Manpower, Personnel, and Training)
Head, Research, Development, and
Studies Branch (Op-115)
1812 Arlington Annex
Washington, DC 20350

Director
Civilian Personnel Division (OP-14)
Department of the Navy
1803 Arlington Annex
Washington, DC 20350

Deputy Chief of Naval Operations
(Manpower, Personnel, and Training)
Director, Human Resource Management
Plans and Policy Branch (Op-150)
Department of the Navy
Washington, DC 20350

Deputy Chief of Naval Operations
(Manpower, Personnel, and Training)
Director, Human Resource Management
Plans and Policy Branch (Op-150)
Department of the Navy
Washington, DC 20350

Chief of Naval Operations
Head, Manpower, Personnel, Training
and Reserves Team (Op-964D)
The Pentagon, 4A478
Washington, DC 20350

Chief of Naval Operations
Assistant, Personnel Logistics
Planning (Op-987H)
The Pentagon, 5D772
Washington, DC 20350

LIST 4
NAVMAT & NPRDC

NAVMAT

Program Administrator for Manpower,
Personnel, and Training
MAT-0722 (A. Rubenstein)
800 N. Quincy Street
Arlington, VA 22217

Naval Material Command
Management Training Center
NAVMAT 09M32
Jefferson Plaza, Bldg #2, Rm 150
1421 Jefferson Davis Highway
Arlington, VA 20360

Naval Material Command
MAT-08K & MAT-08KB (1 copy each)
(J. W. Tweeddale)
CASY(SNL)
Crystal Plaza #5
Room 236
Washington, DC 20360

Naval Material Command
MAT-03
(J. E. Colvard)
Crystal Plaza #5
Room 236
Washington, DC 20360

NPRDC

Commanding Officer (3 copies)
Naval Personnel R&D Center
San Diego, CA 92152

Naval Personnel R&D Center
Dr. Robert Penn (1 copy)
Dr. Ed Aiken (1 copy)
San Diego, CA 92152

Navy Personnel R&D Center
Washington Liaison Office
Building 200, 2N
Washington Navy Yard
Washington, DC 20374


ATE
LMED